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ABSTRACT

The curriculum materials contained in this document were developed through a cooperative effort by educators in the state of Maryland. It was a curriculum project aimed at the meaningful integration of mathematics and science. It is suggested that these materials be used in two significant ways. First, this document can serve as an instructional materials resource collection. An extensive variety of technology topics are covered, with each topic including detailed information sheets identifying the mathematical and scientific principles that could be studied in a technology education activity. Secondly, this document can serve as a materials resource guide. This is accomplished by providing a format and process for the creation of similar classroom instruction materials. Topics include the following: (1) bandsaw; (2) bicycle frame brazing; (3) blind pop riveting; (4) board footage; (5) buffing wheel; (6) design and construction-fiberglass boat; (7) dip molding; (8) drillpress; (9) drills; (10) electric spot welding; (11) injection molding; (12) jigsaw; (13) laser drilling-welding; (14) lathe cutting speeds; (15) micrometer; (16) oxygen-acetylene torch; (17) rotational molding; (18) soldering; (19) thermoforming; (20) tin snips; (21) wood finishes; (22) wood laminating; (23) wood stains; (24) wood turning; and (25) wood waxes. Each of the 25 technology topic entries includes the title, descriptions of the transparencies, science concepts, mathematical concepts, and transparency masters graphically illustrating the topic. A list of additional documents available from the Division of Vocational-Technical Education, Maryland Department of Education is provided. (KR)

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ED341571

TECHNOLOGY EDUCATION



MATHEMATICS AND SCIENCE INTERFACE CURRICULUM PROJECT

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MATH, SCIENCE, TECHNOLOGY EDUCATION INTERFACE

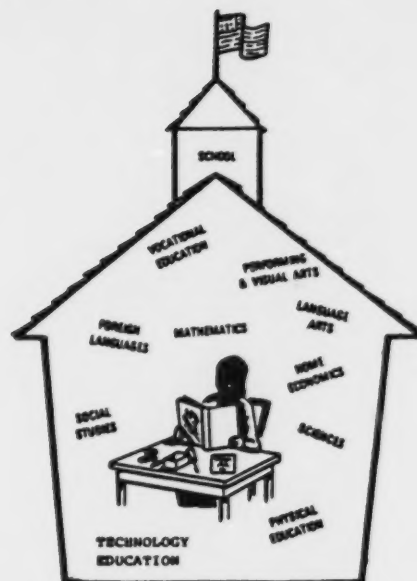


A CURRICULUM PROJECT...

Aimed at enriching the content of industrial arts/technology education as well as demonstrating the potential for this area to make a significant contribution to the students' understanding of mathematics and science in the application of such disciplines in the technology education laboratory.



THE PURPOSE...



There were four distinct purposes for understanding this project. Each of these have significant value; however, collectively they offer substantial rationale for pursuing holistic learning in our public schools.

They are...

To assist understanding and cooperative relationships in our schools between content areas of mathematics, science and technology education.

To provide for the integration of mathematics and science into the teaching of technology education.

To develop curriculum materials for the integration of mathematics and science into technology education.

To provide inspiration and direction for further content integration for all subjects.



THE PROCESS...



The math/science/technology education project was a cooperative effort by concerned educators in the state of Maryland. It was a curriculum project aimed at enriching the content of technology education through the meaningful integration of mathematics and science. This integration should demonstrate the potential for technology education to make a significant contribution to the students' understanding of these subjects through their application in the technology education laboratory.

The project was conducted over a three year period, beginning in the summer of 1985, continuing in 1986, and concluding in 1987. Each year, teachers from public schools throughout Maryland were assembled for two weeks. The organization was provided by the Department of Industrial, Technological and Occupational Education at the University of Maryland, College Park Campus. During these two week periods, teams of educators were involved in the process of creating technology education instructional materials that integrated the subject areas of mathematics and science. Appropriately, each team represented one school and included one teacher from each of the following areas: Industrial Arts/Technology Education, Math and Science. It was the responsibility of the technology teacher to lead the team by providing direction for content development. As each technology teacher identified the content from his/her program, the science and math teachers would analyze the content for science and math applications. The outcome of this effort was the creation of appropriate visual masters that would communicate technological content as well as applied science and math principles. This master would be supplemented with information sheets carefully developed by the math/science members of the team. The information sheets would describe in greater detail the specific science and mathematics principles related to the technology content topic.

Follow-up activities involved workshops and in-service sessions in each of the local education agencies participating in the project. Finally, these curriculum materials were prepared for distribution to all participants, as well as local education agencies throughout the state.

ACKNOWLEDGEMENTS...

This document is the result of a major cooperative effort over a three period at all educational levels.

Project Director...

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Edited By...

Kenneth L. Smith, Technology Education
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County Public Schools.

ACKNOWLEDGEMENTS

Teacher Teams...
(1985)

Arbutus Middle School

Technology Teacher	Steve Bartley
Science Teacher	Linda McCelland
Math Teacher	James Hastings

Calvert High School

Technology Teacher	Carl Fenwick
Science Teacher	Terrance Klazer
Math Teacher	Kevin Michael

Catonsville High School

Technology Teacher	Bill Gibbs
Science Teacher	Buddy Brietenbach
Math Teacher	Ken Berry

Cherry Hill Middle School

Technology Teacher	Wilson Thompson
Science Teacher	Gretchen Lawson
Math Teacher	Kermit Williams

Franklin High School

Technology Teacher	Howard Spears
Science Teacher	Stanislaus Ziolkowski
Math Teacher	Joseph Noto

Gaithersburg High School

Technology Teacher	Willie Hill
Science Teacher	Dr. Donald Poe
Math Teacher	Deno Diamonds

Glen Burnie High School

Technology Teacher	Art Chenowith
Science Teacher	John O'Dell
Math Teacher	Glenna Hilditch

ACKNOWLEDGEMENTS

Teacher Teams...
(1985)

John Hanson Middle School

Technology Teacher	Kenneth L. Smith
Science Teacher	Christine Smith
Math Teacher	Drew Jepsy

North Carroll High School

Technology Teacher	Stephen Shepler
Science Teacher	Dean Packer
Math Teacher	Babette Leister

Sparrows Point Middle School

Technology Teacher	Will Heilman
Science Teacher	Ruth Jensen
Math Teacher	Paul Leimbach

ACKNOWLEDGEMENTS

Teacher Teams...
(1986)

Einstein High School

Technology Teacher	Robert Wotkowski
Science Teacher	Russell Wright
Math Teacher	Mary Carter

John Hanson Middle School

Technology Teacher	Kenneth L. Smith
Science Teacher	Christine Smith
Math Teacher	Drew Jepsy

Oxon Hill High School

Technology Teacher	Charles Algire
Science Teacher	Michael Mickolay
Math Teacher	Diana B. McCusker

Prince George's County Schools

Frank Grahn	George Miles
Robert Gray	Roland Moore
Connie Jones	Nelson Sharpe

Roosevelt High School

Technology Teacher	Joseph Irizarry
Science Teacher	Bobbie Smith
Math Teacher	Mike Reidy

Springbrook High School

Technology Teacher	David Kaplan
Science Teacher	Paul Kroeger
Math Teacher	Regina Skyles

Wilde Lake High School

Technology Teacher	Charles Venable
Science Teacher	Nicholas Zoulias
Math Teacher	Eric Ebersole

Woodlawn Middle School

Technology Teacher	Richard Harbach
Science Teacher	Cheryl Migliarini
Math Teacher	William Gluth

ACKNOWLEDGEMENTS

Teacher Teams...
(1987)

Chesapeake Middle School

Technology Teacher	Thomas Eoannou
Science Teacher	Donald Stenimler
Math Teacher	Dione McManus

Eastern Vocational-Technical School

Vocational Teacher	Earl Crusse
Science Teacher	William Stacy
Math Teacher	Albert Smith

Earle B. Wood Junior High School

Technology Teacher	Mark Green
Science Teacher	Richard Knight
Math Teacher	Julia Pepeta

Galena Middle School

Technology Teacher	Charles Cooper
Science Teacher	Margaret F. Crow
Math Teacher	Kevin Smith

Mergenthaler Vocational-Technical School

Vocational Teacher	Jack Jacobs
Science Teacher	Gail Brayton
Math Teacher	Dwight Evans

North Caroline High School

Technology Teacher	Len Harmon
Science Teacher	Patricia Clay
Math Teacher	Mike Miller

North Carroll Middle School

Technology Teacher	Robert Lenz
Science Teacher	Tim Hontz
Math Teacher	Linda Guillen

ACKNOWLEDGEMENTS

Teacher Teams... (1987)

Owings Mill High School

Technology Teacher	Roland Phelps
Science Teacher	Sherman Kopelson
Math Teacher	Sharon Oland

Taney Middle School

Technology Teacher	Dennis Hearn
Science Teacher	Bruce Guinn
Math Teacher	John Davis

West Frederick Middle School

Technology Teacher	Paul E. Dunford
Science Teacher	Paula Lawton
Math Teacher	Rose Geiger

CONTENT INTEGRATION

A RATIONALE...

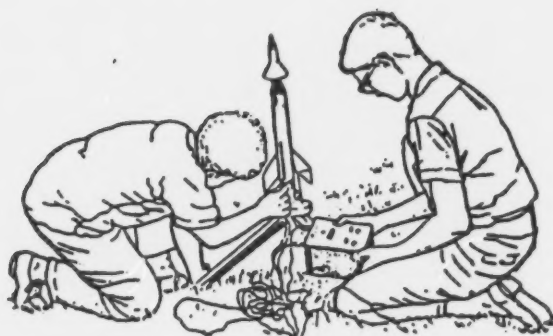


If technology education is to seriously provide for greater understanding and awareness of technological achievement, the issue of holistic learning must be addressed. If one is to truly understand any technological achievement, anthropological or contemporary, a discovery and realization of the specific scientific and mathematical concepts must be accomplished. To illustrate: a student studying rocket technology can use a few tools and machines to build a model of a rocket in any technology education laboratory. However, if that student is to gain a meaningful understanding of rocket propulsion, the scientific and mathematical relationships causing a rocket to function must become part of the instructional activity. Without this effort, the student is involved in a very superficial program.

It is most important to remember that the constructive activity is a vital part of the technology education experience. Generally, constructed items in class serve to motivate students. This motivation can be used to initiate further investigation into a particular curricular topic. Leading a student into a deeper understanding of a "cause and effect" relationship behind a technical device should be a carefully planned and managed instructional process. This process demands the inclusion of science and mathematics; that is, if understanding is the desired outcome.

Technology education offers, within its content and methodology, a prime vehicle through which the subjects of the school can be unified for relevant, meaningful learning on the part of the student. This is particularly true for mathematics and science. Technology education teachers permit students the opportunity to discover through investigation, research and problem solving the "how and why" relationships of science, math and technology education. This approach to subject integration would then continue and enhance the vital "experiential-active" quality that technology education has always valued.

TECHNOLOGY EDUCATION



A DEFINITION...

Technology education is an experienced-based curriculum area in which students study technology... its evolution, utilization and significance. It develops the technological literacy everyone needs. It involves learning experiences, including the application of mathematics and science, in such areas as communications, construction, manufacturing, power and energy, transportation, including the impact of these areas on the environment and society.



TECHNOLOGY EDUCATION



OPPORTUNITIES TO...

Acquire knowledge, understandings and skills needed to function in a technological environment.

Integrate and apply concepts and skills of mathematics, science and communication.

Explore societal and environmental impacts of technology.

Solve problems through laboratory experiences which incorporate creative inquiry, ingenuity, discovery and interaction with technology.



LONG-RANGE OUTCOME...



It is most desirable that this curriculum integration effort will provide direction for not only technology educators, but all concerned educational personnel pursuing meaningful, holistic learning in our public schools. However, as with any curriculum development experience, its usefulness depends on further creation and appropriate implementation by teachers in their classrooms. This body of work has already furnished sufficient guidance for some workshop participants to design and utilize additional materials suitable for use in their particular programs.

It has been convincingly argued that technology education can lead the way for meaningful, relevant subject integration in our schools. The effort in this curriculum project supports that argument. If teachers from the content areas of mathematics, science and technology education can cooperatively discuss, plan, design and produce curriculum materials such as those included in this document, certainly individual schools or local educational agencies should be able to coordinate similar activities. Technology educators should take this opportunity to provide the leadership necessary for further holistic curriculum exploration. Just as leadership and direction was provided by technology educators during this project, continued educational attempts to integrate mathematics and science into the technology education curriculum should be guided by individuals in technology education. The technology laboratories and curricula offer students that place within the school that can bring real understanding to all subjects.

The instructional materials contained in this document serve as examples of successful curriculum integration. The key to this success was carefully managed cooperation among concerned educators. Continued usefulness of these materials will certainly depend on carefully planned and supervised strategies. It is suggested that this document provide the impetus for workshops, seminars and various other in-service activities at all educational levels. The goal... appropriate and meaningful application of mathematics and scientific concepts into technology education.

CLASSROOM USE...



One of the goals of this document is to provide for continued mathematics, science and technology integration. With this in mind, it is suggested that these materials can be used in two significant ways. However, it is important to realize that effective use of this document greatly depends on the initiative of technology teachers, resource teachers and supervisory personnel.

First, this document can serve as an instructional materials resource collection. The teams of educators who participated in the three year workshop have produced an extensive variety of technology topics presented as part of their individual programs. Each topic includes detailed information sheets identifying the mathematical and scientific principles that could be studied in the technology education activity. The quantity and depth of study for these math and science concepts remains at the discretion of the technology teacher. Variations in content usefulness will also depend on individual school or classroom conditions as well as the grade level of students.

Because of the wide range of technology topics presented, many teachers will be able to simply review and select items appropriate for immediate use in the classes. Some will be useful with only minor modifications to subject content. After basic planning and curriculum consideration, most technology teachers should be able to include some of these materials as part of their technology instruction.

Secondly, this document can serve as a materials resource guide. This is accomplished by providing a format and process for the creation of similar classroom instructional materials. It is suggested that after reviewing these materials and understanding the cooperative 'teaming' process used in their creation, technology teachers will adopt a similar approach as they develop classroom materials appropriate to their programs. Although technology teachers generally possess backgrounds in mathematics and science, it is most valuable to pursue the assistance of the school's mathematics and science personnel in the identification of those principles peculiar to their programs. This effort will insure accurate and relevant subject integration with the technology education curriculum. In addition, math and science teachers could also reinforce technology education concepts in their curricula.

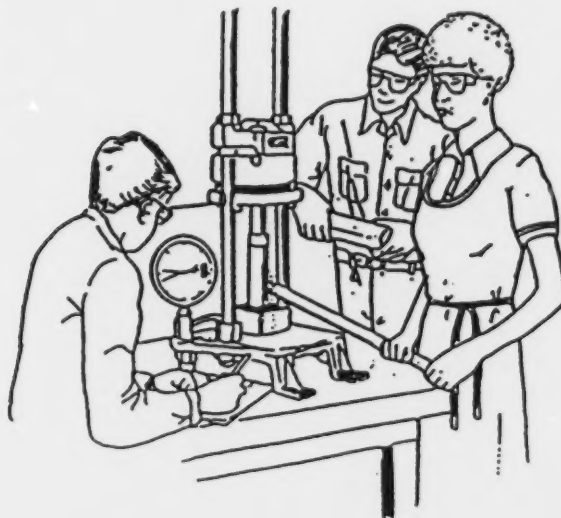


ORGANIZATION...

This document is organized into five categories. These categories are selected from the content areas identified in the definition of technology education.

Each technology topic has been placed in the most appropriate content area. However, some topics may be appropriate in more than one area.

Each content category includes a statement of definition and a point of view.



XVIII

CONTENT AREAS:



- **COMMUNICATIONS**



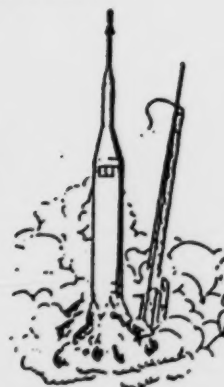
- **CONSTRUCTION**

- **MANUFACTURING**



- **POWER AND ENERGY**

- **TRANSPORTATION**

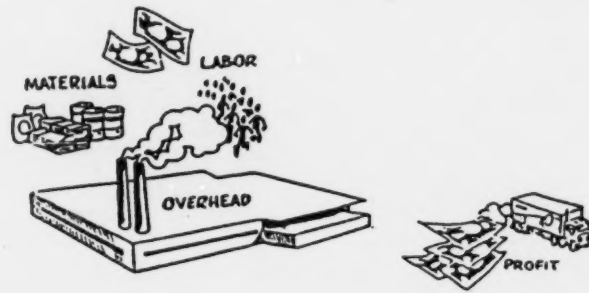


MANUFACTURING

Point of View...

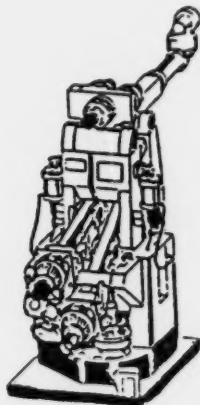
One individual working hard and producing their own needs seems reasonable at first glance. But, not so fast. In reality, this one person production system would never be able to satisfy the needs and wants of society today, not to mention the future. Early attempts to provide the things needed in a primitive and simple culture focused on food, shelter and clothing. The effort to produce those items necessary just to survive was enormous. But eventually the human ability to reason and create offered shortcuts to survival. As time passed, discoveries about the physical world, combined with creative imaginations, produced useful technologies. The fuel for these discoveries was social needs. Needs began to change as society evolved and became much more complex and sophisticated. Producing items necessary to survive was common place and relatively easy. This enabled society to develop production systems for wants, not just survival needs. Individuals wanted choices and improved quality. Eventually, individuals were able to select from a wide variety of consumer products.

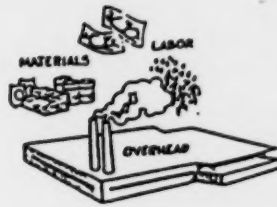
The dominant production/manufacturing method used by a society certainly reflects the developmental state of that culture. Early history reveals craft shops were abundant. One individual produced special products one at a time. Tools used were simple, required human muscle, and ample amounts of time to master. However, as populations increased, production techniques needed more efficiency, greater production, less human effort, and improved quality. These demands guided society into the Industrial Revolution. Factories powered by moving water and steam ran machines that rapidly produced the variety of goods people wanted at that time. This revolution gradually changed the quality of life. Consumable goods for leisure or avocation could now be created. Life in the urban areas near these factories became very convenient. Society's future growth seemed directly linked to the continued improvements in manufacturing and production technology. That link continues to exist. The ability to produce quality products will certainly depend on the applications of math and science in the creation of tools, machines, materials, and processes.



MANUFACTURING

AS A CONTENT AREA IS THE STUDY OF THE ORGANIZATION AND USE OF RESOURCES INCLUDING... PEOPLE, TOOLS, MACHINES, TIME, MATERIALS, PROCESSES AND CAPITAL FOR THE PURPOSE OF PRODUCTION OF CONSUMER GOODS.





PRODUCTION SYSTEMS

CRAFT SHOP / HOME PRODUCTION



FACTORY SYSTEMS



ASSEMBLY LINE / MASS PRODUCTION



AUTOMATED LINE PRODUCTION



COMPUTER AIDED MANUFACTURING (CAM)



COMPUTER INTEGRATED MANUFACTURING (CIM)



FLEXIBLE MANUFACTURING



EMERGING PRODUCTION SYSTEMS
(FUTURE)



MANUFACTURING TECHNOLOGY TOPICS

BANDSAW

BICYCLE FRAME BRAZING

BLIND POP RIVETING

BOARD FOOTAGE

BUFFING WHEEL

DESIGN AND CONSTRUCTION-FIBERGLASS BOAT

DIP MOLDING

DRILLPRESS

DRILLS

ELECTRIC SPOT WELDING

INJECTION MOLDING

JIGSAW

LASER DRILLING-WELDING

LATHE CUTTING SPEEDS

MICROMETER

OXYGEN-ACETYLENE TORCH

ROTATIONAL MOLDING

SOLDERING

THERMOFORMING

TIN SNIPS

WOOD FINISHES

WOOD LAMINATING

WOOD STAINS

WOOD TURNING

WOOD WAXES

XXIII

ADDITIONAL DOCUMENTS

The following documents are also available from the Division of Vocational-Technical Education, Maryland State Department of Education.

POWER & ENERGY

ANEMOMETER
AUTOMOTIVE AIR CONDITIONING
 ACCUMULATOR
 COMPRESSOR
 CONDENSER
 EVAPORATOR
BASIC ELECTRICAL CIRCUITS
BATTERY
BIMETAL DEVICES
CARBURETOR
CAPACITORS
CASTER
CATALYTIC CONVERTER
COMBUSTION CYCLE
COMPUTER COMMAND CONTROL
CONDUCTORS
COPPER WIRE RESISTANCE
DIESEL COMPRESSION RATIOS
DIODE
DRY CELL BATTERY
ELECTROMAGNETIC FIELD STRENGTHS...
 CORE PERMEABILITY
ELECTROMAGNETIC RELAY
ELECTROMAGNETS
ELECTRON BEAM DEFLECTION
ELECTRONIC MASE
FLYBALL GOVERNOR
FOUR STROKE ENGINE
FULL WAVE RECTIFICATION
GEARS
HALF WAVE RECTIFICATION
HYDRAULICS
IMPULSE STEAM TURBINE
IMPULSE WATER TURBINE
INCANDESCENT LAMP
LASER
LIFT PUMP
LIGHT EMITTING DIODES
LOGIC INVERTER
MAGNETIC COMPASS
MICROWAVE OVEN
MOVING COIL AMMETER
NEWCOMEN STEAM ENGINE
OHM'S LAW
OVERSHOT WATER WHEEL
PARABOLIC FURNACE
PARALLEL CIRCUITRY
PASSIVE SOLAR HEATING
RELATIONSHIP OF VOLTAGE TO
 BOYLE'S/CHARLES' LAWS
RESISTORS
ROCKET ENGINES
ROCKETRY
SERIES CIRCUITRY
SERIES-PARALLEL CIRCUITRY
SILICON PHOTOVOLTAIC CELL
SIMPLE MACHINES
SNOW WINDMILL
SOLAR ENERGY
SOLAR HEATER
SOLAR WATER HEATER
TRANSFORMERS
TRANSISTOR OPERATION
TURBOCHARGING
TWO STROKE ENGINE
WIND TUNNEL
WIND TURBINE
WOOD BURNING STOVE

CONSTRUCTION

ABRASIVE TECHNOLOGY
ARCHITECTURAL MATERIALS UNDER COMPRESSION LOAD
BENDING WOOD
BRIDGE CONSTRUCTION
BRIDGE TRUSS
CHARPY IMPACT TESTING
CONCRETE STRENGTH
COPPER ELECTROPLATING
DECK CONSTRUCTION
DIMENSIONAL CHANGE IN WOOD
HAMMER
HARDENING OF STEEL
HEAT TREATING METALS
HOUSE CONSTRUCTION
JOINING WITH SILVER SOLDER
MITER JOINTS
NAILING
ROOF FRAMING
SCREWDRIVER
STEEL
TRUSSES
WALL INSULATION

COMMUNICATIONS

BELL'S LIQUID TELEPHONE
CAMERA
CRYSTAL RADIO
DYNAMIC MICROPHONE
EARLY RADIO
EARLY TELEVISION
EDISON'S PHONOGRAPH
FIBER OPTICS
HOLOGRAPHY
LIGHTHOUSE
PERISCOPE
PHONOGRAPH
PHOTO ENLARGER
PINHOLE CAMERA
PRINTING PRESS
PROBLEM SOLVING
RADAR
RADIO SYSTEMS
SATELLITE TELEVISION
SPEAKER CONSTRUCTION
SUNDIAL
TELEGRAPH
TELEPHONE OPERATION
TELESCOPE
TELEVISION CAMERA

TRANSPORTATION

BELL XP-59A AIRACOMET...FIRST AMERICAN JET
CANAL LOCK
CONESTOGA WAGON
GOODARD'S LIQUID FUEL ROCKET
HOT AIR BALLOON
MAGNETIC LEVITATION TRAIN (MAGLEV)
METRIC DRAGSTER
OPERATION SAIL
REACTION ENGINE CAR
WRIGHT BROTHERS AIRPLANE

TITLE: The Band Saw

Area of Study: Process

DESCRIPTION:

This transparency will enable students to gain an understanding of forces, work, simple machines and power with use of the band saw. The power produced by such a machine can be measured through mathematics applications and calculations. The variables involved require an understanding of several science principles described below. The culmination of these concepts will certainly give students a better understanding and appreciation of this complex machine.

SCIENCE CONCEPTS:

1. Force - The force applied to the material being cut by the band saw, sometimes referred to as the effort, is a topic discussed by the instructor. An inconsistent application of force often results in a rough edged cut, an uneven cut and sometimes damage to the blade of the saw. The amount of force being applied is determined by the operator who considers the type of material being cut and the type of blade.
2. Work - In mechanical systems work involves two variables; the distance an object moves and the amount of force applied to the object. $WORK = FORCE \times DISTANCE$
3. Power - The amount of power can be computed after the amount of work is determined. The power formula is $POWER = \frac{WORK}{TIME}$. The work done divided by the amount of time to do the work. Power is transmitted from an initial source to the machine or mechanism which produces the desired motion or work.
4. Acceleration - The rate at which speed is changing caused by a force.
5. Velocity - A speed in a given direction (a vector quantity), along some straight line.
6. Speed - Rate of motion.
7. Circumference - The distance around a wheel (circle).

TITLE: The Band Saw

Area of Study: Process

DESCRIPTION:

This transparency will enable students to gain an understanding of forces, work, simple machines and power with use of the band saw. The power produced by such a machine can be measured through mathematics application and calculations. The variables involved require an understanding of several science principles described below. The culmination of these concepts will certainly give students a better understanding and appreciation of this complex machine.

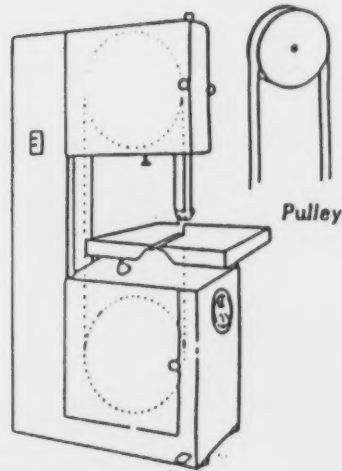
MATH CONCEPTS:

1. Finding the diameter of a wheel. This will include using a measuring device (ruler) to find the width of each wheel being encircled by a blade.
2. Solving the formula for finding the circumference of a circle will indicate the size of each wheel. To determine the circumference of a circle the formula $C = \pi \times d$ is used. π () will equal 3.14; d will equal the diameter of the wheel. The product of the two will total the circumference.
3. To determine the rate of revolutions of each wheel one must be given the standard rate of speed then use the formula
$$a = \frac{v_2 - v}{t}$$
 where a = acceleration; v_2 = the final velocity; v = the initial velocity and t = time. A variation in wheel size will in determine the rate of speed of the blade of the band saw.
4. Other concepts arise when materials are being acted upon (changing form) by coming in contact with the saw blade.

work
force
power

distance
time
cutting speed

MECHANICS OF SIMPLE MACHINES THE BAND SAW



a complex machine composed
of two simple machines.

C=circumference

cs=cutting speed

d=diameter

rpm=revolutions per minute

D=distance

S=speed v_1 =initial velocity

F=force

t=time

f= friction

v_2 =final velocity

W=work

a=acceleration

$$S = \frac{D}{t}$$

$$f = \frac{R}{F}$$

$$S = \frac{RD}{ED}$$

$$F = 1\text{kg}/1\text{m}/\text{sec} \text{ (1N)}$$

$$cs = \frac{C}{12} \times \text{rpm}$$

$$P = \frac{W}{t}$$

$$a = \frac{v_1 - v_2}{t}$$

$$C = \pi \times d$$

TITLE: Technology of Bicycle Frame Brazing

DESCRIPTION:

Better quality bicycle frames are brazed together. Tubes are joined in a "lug" and brazed with silver braze. The brazing process is preferred over welding for the following reasons:

1. Frame tubes of Chromium - Molybdenum can be designed with thin-gauge walls.
2. The extreme heat of welding destroys the desired strengths of the tubes.
3. Brazing temperatures are lower, and do not weaken the material.

SCIENCE CONCEPTS:

1. Alloying metals such as Chromium and Molybdenum with Steel changes the steel, making it stiffer and more ductile.
2. Ductility = the ability of a metal to be drawn (as in making tubing).
3. High heat welding (6,000° - 10,000°) changes the molecular structure of the material and negates the advantages of the alloys.
4. The heat of brazing is not sufficient to alter the lattice structure of the steel crystals so the strength of the tube is not lost.
5. Steel is hardened in manufacturing into a body centered cubic lattice, reheating can cause a change to face centered cubic lattice.

TITLE: Technology of Bicycle Frame Brazing

DESCRIPTION:

The purpose of this lesson is to explain to metal shop students that the materials used in class are very often a mixture of two or more metals. The students will understand that the mixture is created to produce desirable characteristics. The desirable characteristics are: tensile strength, melting point, temperature, and ductility. Often the amounts of the alloying metals used are very small, less than one percent. Therefore a knowledge of fractional percents is essential.

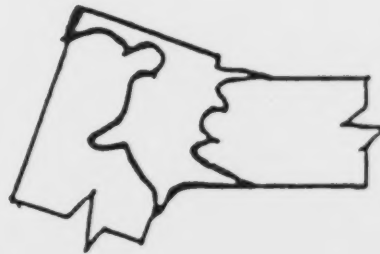
MATH CONCEPTS:

1. Comparison of tensile strength to gap clearance: The ideal gap clearance for maximum tensile strength is approximately three thousandths of an inch, which is about the thickness of a human hair.
2. Melting Point: As an alloy mixture varies, its melting point changes. For example, the melting point of silver braze is 1,100° F and the melting point of pure (bronze) braze is 1,600° F.
3. Fractional Percents: The alloy of steel we are using in this lesson is Chromium - Molybdenum 4130. The amount of Cr in the alloy is 0.70% and the amount of Mo in the alloy is 0.15%. The student will need to understand that these percents are very small, less than $\frac{1}{100}$. To be exact, $0.70\% = \frac{0.7}{100} = \frac{7}{1000}$. Similarly, $0.15\% = \frac{.15}{100} = \frac{15}{10,000}$. Another way to express these fractions is the concept of part to whole. For example, if a block of wood is divided into 1000 pieces, then 0.70% would be 7 pieces out of 1,000 pieces.

TECHNOLOGY OF BICYCLE FRAME BRAZING

BRAZING FLUX

1. SHIELDS FROM OXIDATION
2. CLEANS METAL
3. AIDS CAPILLARY FLOW OF BRAZE ALLOY



OPTIMUM GAP

DETERMINES HIGHEST TENSILE STRENGTH

BRAZE ALLOY

72% AG 28% CU

BONDS WITH LOW MELTING

TEMPERATURE 1100-1500 F

HAS MINIMAL EFFECT ON

THE TUBING STRENGTH

BRAZED CONSTRUCTION

TECHNOLOGY OF BICYCLE FRAME BRAZING

WHY IS IT BRAZED?

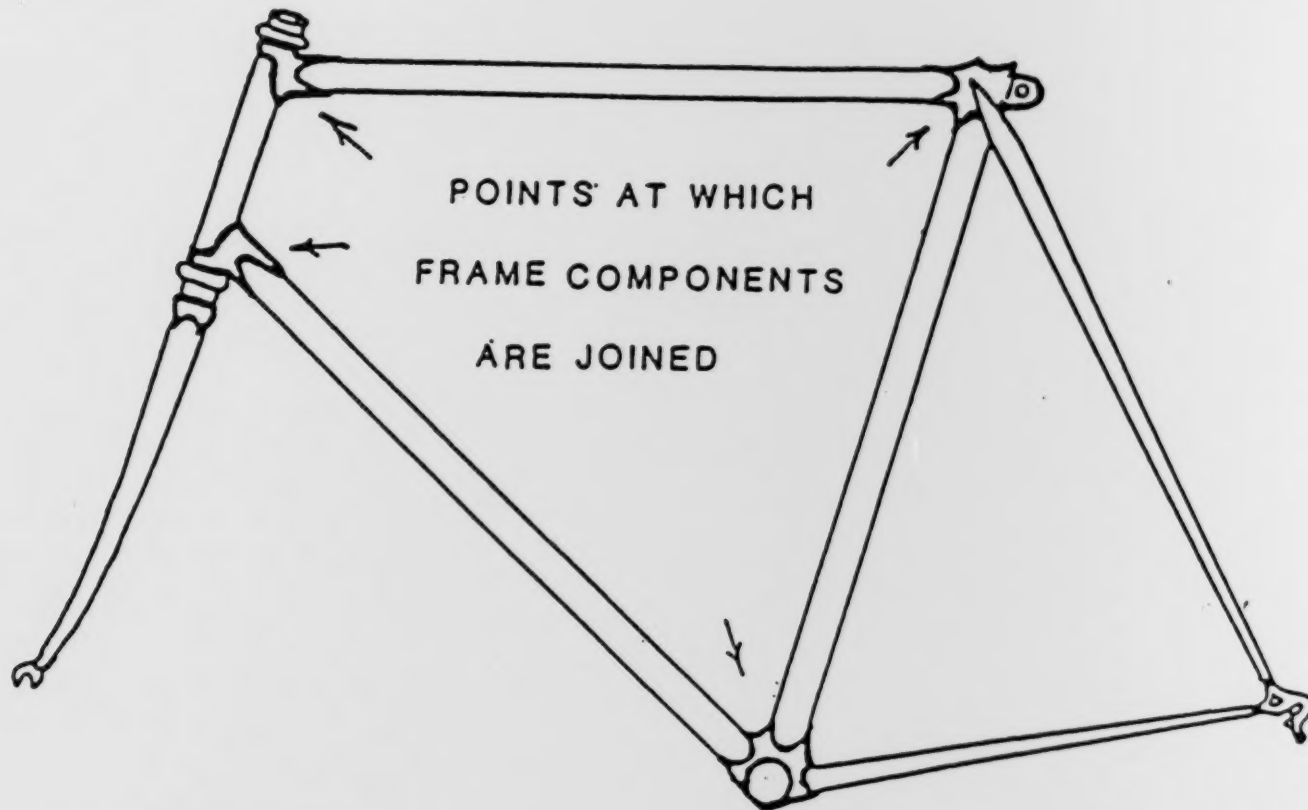
HIGH QUALITY BICYCLE FRAMES ARE
MADE FROM THIN WALL ALLOY TUBING



STANDARD TUBE



THIN TUBE



TITLE: Blind "POP" Riveting

DESCRIPTION:

A method for fastening materials, mostly metal, especially when only one side of the fastening point is available to the worker.

SCIENCE CONCEPTS:

Levers: The lever is a rigid bar that can be rotated about a fulcrum in order to lift a load. Levers can help us do work by supplying a mechanical advantage to our efforts. There are basically three types of levers but only one, a class I lever is used in this device.

In all levers there are three points of interest. The fulcrum, the input force and the output force. Also we must be concerned with the distance from the fulcrum to the input force, the input arm, and the distance from the fulcrum to the output force, the output arm. In the class I lever the input arm length is longer than the output arm length and the fulcrum is between the two points where the forces are applied.

Tensile Stress: The ratio of the force applied to the rod, compared to the cross-sectional area of the rod.

Strain: The strain on a metal rod is defined as the ratio of the change in size to the original size or the change in length to the original length.

Tensile Strength (breaking strength): This is the value of the tensile stress when the material breaks. This value is normally given in pounds per square inch.

Malleability: The property exhibited by metals that allows them to be hammered, rolled or bent without cracking or breaking. In "POP" riveting the rivets used are made of "soft" metal. Aluminum and copper are the two metals in common use for these. As the mandrel is pulled by the lever, the head of the mandrel deforms the metal rivet because the material it is made of is malleable.

Young's Modulus: Any material that can be stretched and will return to its original shape or length in displaying elasticity. If a wire or rod made of metal is stretched to a point where the ratio of the stress (defined as the force on the rod over the cross-sectional area of the rod) to the strain (defined as the change in length over the original length) is greater than a definite value (young's modulus) the wire or rod will be stretched beyond the elastic limit of the material and the wire or rod will not be able to return to its original shape or length. In using the "POP" rivet gun young's modulus (for the mandrel material) must be exceeded in order for the mandrel to be pulled apart.

TITLE: Blind "POP" Riveting

DESCRIPTION:

A method for fastening materials, mostly metal, especially when only one side of the fastening point is available to the worker.

MATH CONCEPTS:

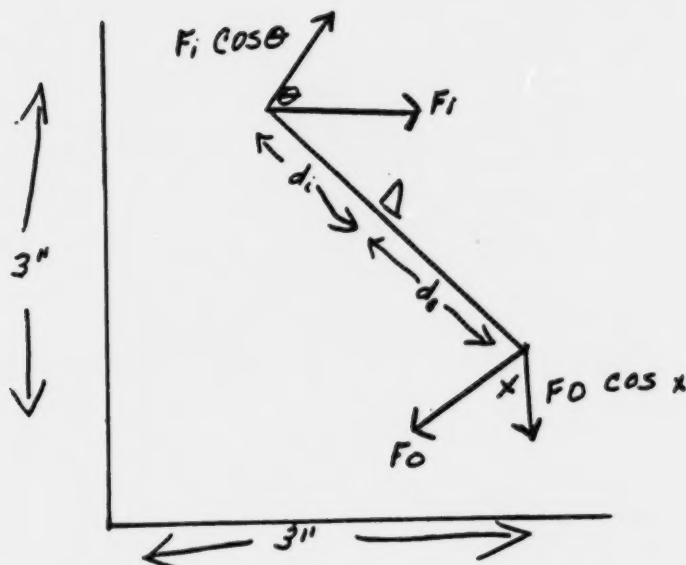
1. The simple class I lever with both forces opposing on either side of the fulcrum is used in more than one application. In the application of hand force to operate the pop rivet we are using a simple lever and if the forces applied are normal than the equation becomes:

$$F_i D_i = F_o I_o \quad \text{where} \quad \begin{array}{ll} F_i & \text{input force} \\ I_i & \text{input distance} \\ F_o & \text{output force} \\ d_o & \text{output distance} \end{array}$$

Inside the pop rivet gun the mechanism which allows the mandrel to be torn is a gain a lever but in this lever the forces are acting at an angle to the lever arms.

The fulcrum point represents the point of the spreader while the lever arm represents one side of the jaws.

$$X = 90 - \theta$$



The equation is:

$$F_i \cos X \cdot d_i = F_o \cos(90-\theta) \cdot d_o$$

2. The second math concept has to do with ratio since the process involves pulling apart the sandrel.
The sandrel is pulled apart by exceeding the elastic properties of the metal. The equations involved are:

$$\text{Stress} = \frac{F}{A} \quad \text{Internal force to distort a substance} \\ \text{Area}$$

Hooke's Law

$$\text{Modulus of Elasticity} = \frac{\text{Stress}}{\text{Strain}}$$

Where strain is the ratio of the change in size or shape to the original size or shape.

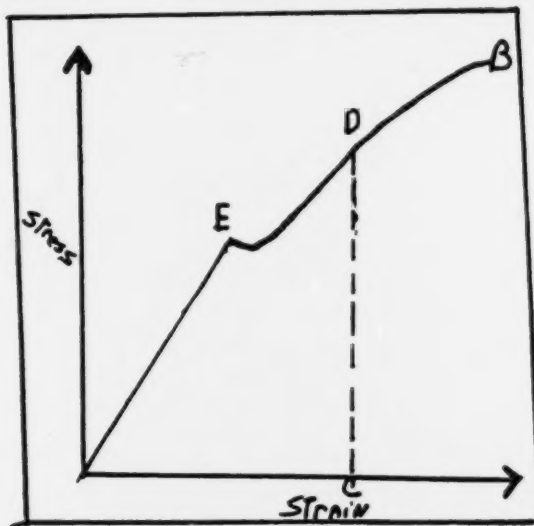
$$\text{i.e. Strain} = \frac{\Delta L}{L} \quad \text{increase in length} \\ \text{original length}$$

The ratio of stress to strain.

$$Y = \frac{F/A}{\Delta L/L}$$

is known as Young's Modulus.
for elastic materials
and are constant values
which are material dependent.

Exceeding the Y value will permanently deform the material.



Graph of Stress versus Strain - Up to Point E the metal will act as an elastic substance and return to its original form. Beyond point E it will be deformed permanently. At Point B it will break.

3. A third concept involves graphing: i.e.

Stress versus strain as shown in diagram which shows a linear relation to point E (Elastic limit of material)

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4. A forth concept has to do with the spring action supplying force to hold the spreader against the jaws.
The equation involved with a force F and displacement X is given by

$$F = - k x \quad \text{Where } k \text{ is constant of the spring}$$

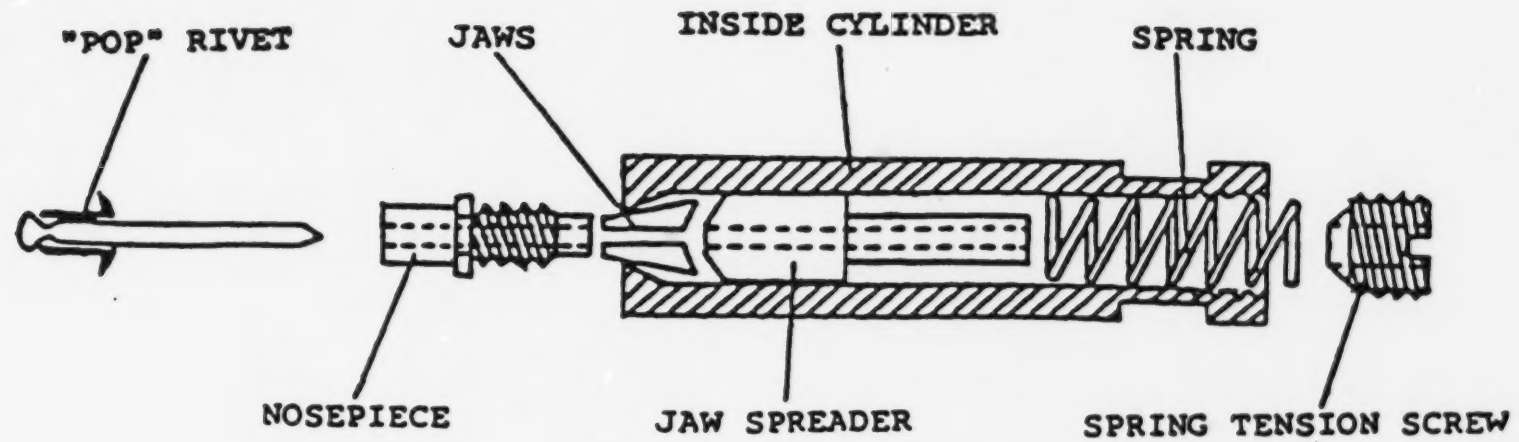
and since $F = MA$ The acceleration of mass
 M can be calculated

$$MA = - k x$$

$$A = \frac{- kx}{M}$$

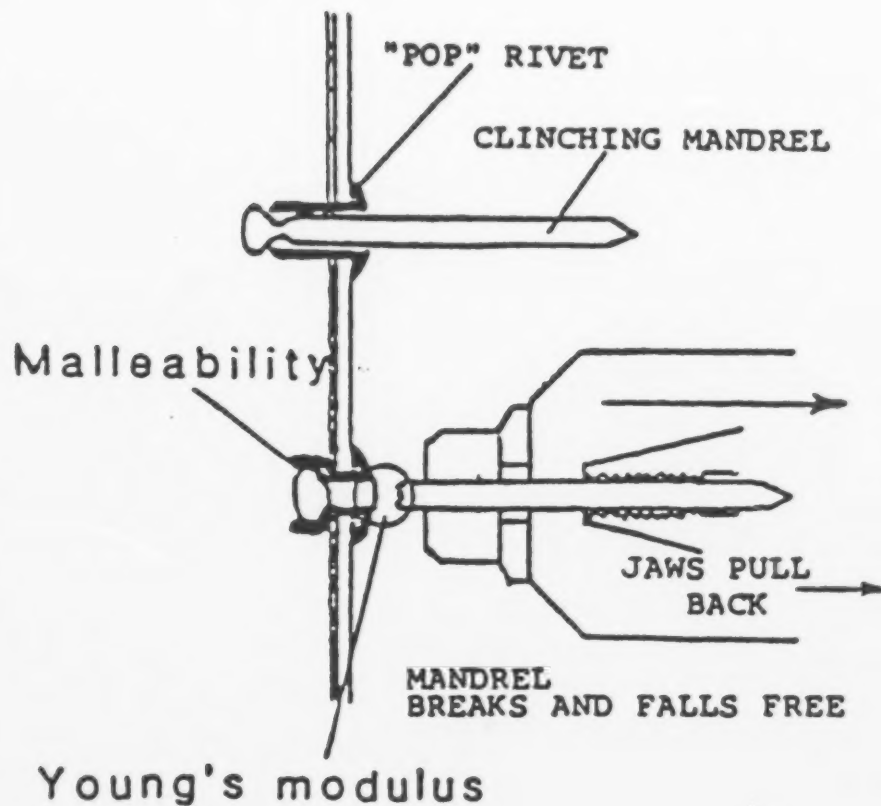
Where A = Acceration due to force of spring.

BLIND "POP" RIVETING

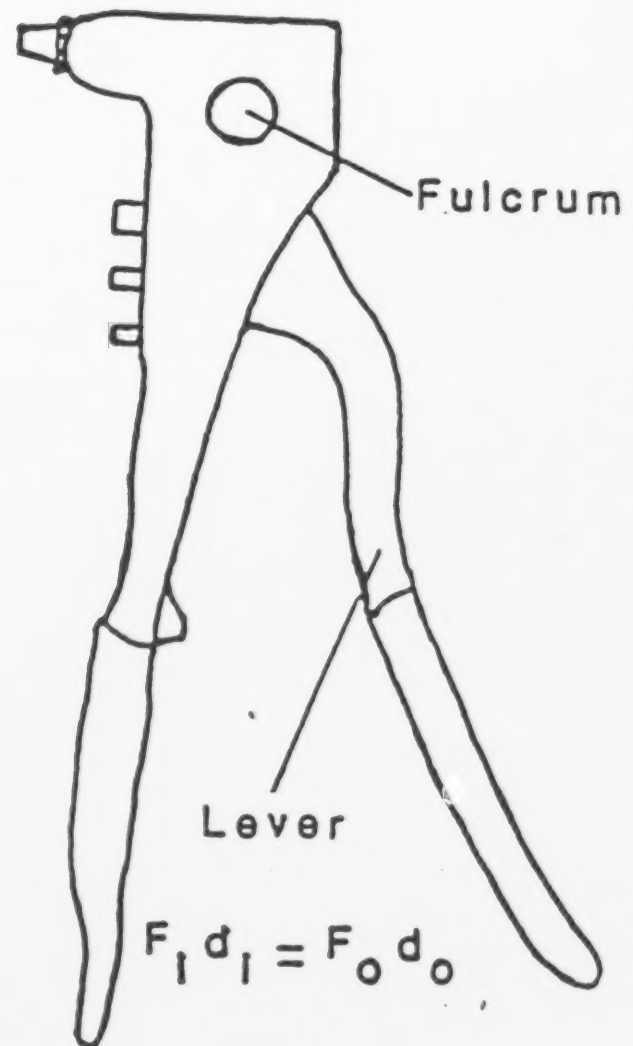


BLIND "POP" RIVETING

HOW A "POP" RIVET WORKS



SETTING TOOL



Force in x distance in =

Force out x distance out

TITLE: Board Footage Formulas

DESCRIPTION:

This information sheet contains the definition of a board foot, the two formulas used to find the number of board feet in a piece of lumber, and an explanation of the two equivalent equations.

MATH CONCEPTS:

1. By definition one board foot is a piece of lumber 1 inch thick, 1 foot long and 1 foot wide, or its equivalent.
2. Volume of a rectangular solid. Use $V = LWH$ to develop the relationship that one board foot is equivalent to 144 cubic inches.
3. Equivalent equations. The two equations given to find the board feet in a piece of lumber are equivalent.

$$\frac{\text{No. of Pieces} \times T'' \times W'' \times L'}{12} = \frac{\text{No. of Pieces} \times T'' \times W'' \times L'}{144}$$

- A. The product of the number of pieces of lumber times the thickness (T) in inches, times the width (W) in inches becomes one number. Use the multiplicative property of equality, the associative property of multiplication, the axiom of multiplicative inverses, and the multiplicative property of 1 to show that

$$\frac{L'}{12} = \frac{L'}{144}$$

- B. Rename each fraction by using the rules dealing with the multiplication of fractions and

$$\frac{1}{12}(L') = \frac{1}{12}\left(\frac{L'}{12}\right)$$

- C. Use the multiplicative property of equality and multiply each side by 12.

$$12\left[\frac{1}{12}(L')\right] = 12\left[\frac{1}{12}\left(\frac{L'}{12}\right)\right]$$

- D. Then, by the associative property of multiplication,

$$\left(12 \cdot \frac{1}{12}\right)L' = \left(12 \cdot \frac{1}{12}\right)\left(\frac{L'}{12}\right)$$

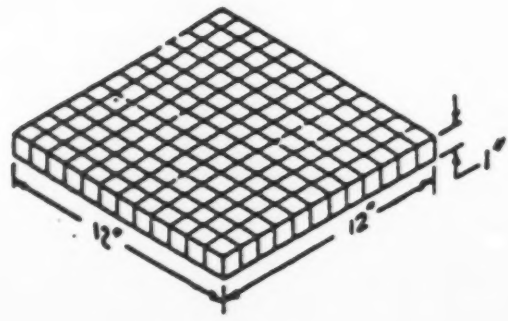
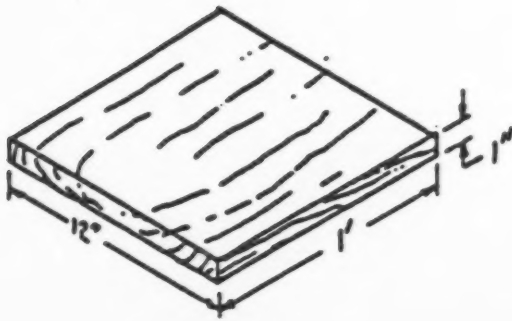
- E. When the axiom of multiplicative inverses, the equation becomes

$$1 \cdot L' = 1 \cdot \frac{L'}{12}$$

F. This becomes $L' = \frac{L'}{12}$ by using the multiplicative property of 1. This states that the total number of inches divided by 12 yields the total number of feet.

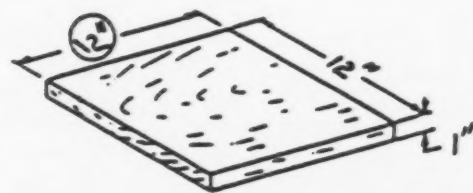
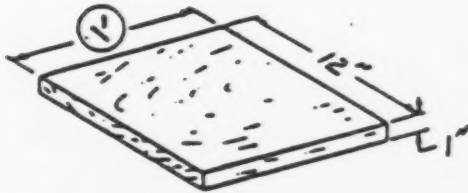
4. The multiplicative property of equality states: If $a = b$, then $ac = bc$ (a, b, c , are real numbers).
5. The associative property of multiplication states $a(bc) = (ab)c$ (a, b, c are real numbers).
6. The axiom of multiplicative inverses states (a is a non-zero real number)
$$a \cdot \frac{1}{a} = a$$
7. The multiplicative property of 1 states 1 times $a = a$ times 1 = a (a is a real number).
8. The linear relationship between inches and the number of feet (1 foot = 12 inches) is necessary to convert the total number of inches into the total number of feet.

BOARD FOOTAGE FORMULAS



1 BD. FT. IS THE SAME AS 144 CU. IN.

TO CALCULATE THE NUMBER OF BD. FT. USE:



$$\frac{\text{No. pcs.} \times T'' \times W'' \times \text{L}^{\text{FEET}}}{12} =$$

$$\frac{\text{No. pcs.} \times T'' \times W'' \times \text{L}^{\text{INCHES}}}{144}$$

THE TWO FORMULAS ARE EQUIVALENT
BECAUSE

$$\frac{L'}{12} = \frac{L''}{144}$$

$$\frac{1}{12} (L') = \frac{1}{12} \left(\frac{L''}{12} \right)$$

$$L' = \frac{L''}{12}$$

TITLE: THE BUFFING WHEEL

CATEGORY: MACHINE

DESCRIPTION:

Buffing is a machine process by which a high polish is put on plastic. Buffing work is done with a rotating cloth wheel and a fine abrasive, usually tripoli or red rouge. The buffing wheel is usually mounted on a double-shaft motor that rotates at 1,750 rpm.

SCIENCE CONCEPTS:

1. Newton's First Law of Motion--a body at rest, and a body in motion tends to continue in motion with a constant speed in a straight line, unless acted upon by an unbalanced force.
2. Speed--the time rate of change of distance--that is, a distance traveled in a time interval.
3. Velocity--the time rate of change of distance in a given direction.
4. Newton's Third Law of Motion--when an object exerts a force on a second object, that second object exerts an equal and opposite force on the first object.
5. Angular velocity--the angular distance through which an object rotates in some time interval, divided by that time interval.
6. Linear speed--the distance an object travels in one minute. If the object is rotating, then its linear speed is equal to the circumference of its circle of rotation divided by the angular velocity.
7. Centripetal force--the force that causes an object to move in a curved, or circular path. The force is directed to the center of the circle.
8. Centrifugal force--the reaction to centripetal force.
9. Torque--a twisting or turning action that tends to produce rotation.

TITLE: THE BUFFING WHEEL

CATEGORY: MACHINE

MATHEMATICAL CONCEPTS:

1. Whole number operations
2. Decimal operations
3. Linear measurement
4. Time
5. Metric system
6. Equations
7. Formulas

Circumference $2 \pi r$; πd

Angular velocity $r p m$

Linear speed $V = 2 \pi r N$; $V = \pi d N$

Acceleration $a = \frac{\Delta V}{t}$

Velocity $V = \frac{\Delta D}{t}$

Centripetal Force $F_c = m \times \frac{V^2}{R}$

Torque $T = F R$

Power $P = \frac{W}{t}$

Work $W = F D$



THE BUFFING WHEEL

THE BUFFING WHEEL IS THE FINAL STEP USED TO POLISH PLASTIC. THE WORK IS DONE WITH A CLOTH WHEEL ROTATING AT 1,750 RPM, AND A FINE ABRASIVE.

SCIENCE

NEWTON'S LAWS OF MOTION

ANGULAR VELOCITY

LINEAR SPEED

CENTRIPETAL FORCE

CENTRIFUGAL FORCE

TORQUE

FRICTION

MATH

WHOLE NUMBER OPERATIONS

DECIMAL OPERATIONS

LINEAR MEASUREMENT

TIME

METRIC MEASUREMENT

EQUATIONS

FORMULAS

TITLE: CONSTRUCTION DESIGN OF A FIBERGLASS FLAT BOTTOM BOAT

CATEGORY: CONSTRUCTION

DESCRIPTION:

The study and design of a flat bottom boat will include the use of tools, equipment and materials to be blended in experience and instruction. Characteristics of industrial materials, machining processes and production tooling will be supported by the following math concepts: angle measure, center of gravity, linear feet, surface area, volume, and formula interpretation. The science concepts to be discussed are the chemical bonding of plastics, including an atomic analysis of bonding, also buoyancy and surface tension.

SCIENCE CONCEPTS:

1. A chemical bond is a process in which atoms link together.
2. A covalent bond is a chemical bond where electrons are shared in the outer region of the atom.
3. Buoyancy is the familiar lifting effect of a fluid upon a body wholly or partly submerged in it.
4. The principle of Archimedes states that the buoyant force is equal to the weight of that body of the fluid which the submerged body displaces and may be treated as a single force acting vertically upward through the center of gravity of the displaced fluid.
5. Fluid surfaces exhibit certain features resembling the properties of a stretched elastic membrane.
6. The value of the surface tension is determined by the nature and the physical condition of the two substances in contact.
7. Center of gravity is the point through which the resultant force of gravity acts no matter how the body is oriented.
8. The center of gravity is the same as the center of mass.

TITLE: CONSTRUCTION DESIGN OF A FIBERGLASS FLAT BOTTOM BOAT

CATEGORY: CONSTRUCTION

MATHEMATICAL PRINCIPLES AND CONCEPTS:

Given:

l=length

w=width

h=height

b₁ and b₂=parallel bases

S.A.=surface area

v=volume

γ=surface tension

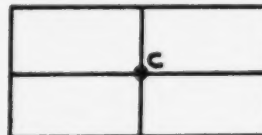
Γ=variable of surface tension

μ_i=chemical potentials

S^a=entropy per unit area of the surface phase

Γ_i=adsorption of components

1. Geometric shapes: rectangle, triangle, trapezoid
2. To find the surface area:
Rectangular shape: S.A.=l x w
Triangular shape: S.A.=½(l x w)
Trapezoid shape: S.A.=½h(b₁ + b₂)
3. To find the volume:
v=surface area of base x height
4. Center of gravity--the single point at which the weight could be held and be in balance in all directions. Find the point of intersection of the medians of the sides of the geometric shape.

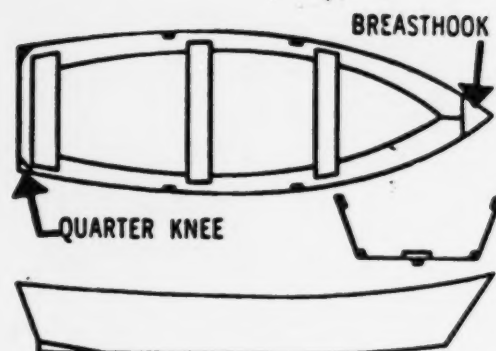


5. Units of measure
6. Operations with fractions (to the nearest 1/16 inch)
7. Use of measuring instruments--measuring tape, architect scale, compass for drawing, protractor, combination square and T-bevel.
8. Gibbs Formula. Calculus interpretation of the total differential of the surface tension γ in the variable Γ and chemical potentials μ_i is

$$d\gamma = -S^a dT - \sum_i \Gamma_i d\mu_i$$

where S^a is the entropy per unit area of the surface phase and Γ_i the adsorption of component i.

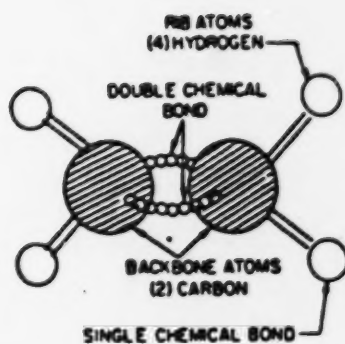
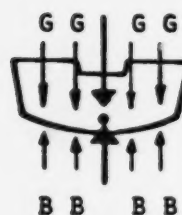
DESIGN & CONSTRUCTION OF A FIBERGLASS FLATBOTTOM BOAT



CENTER OF GRAVITY



BUOYANCY



MATH CONCEPTS

VOLUME
SURFACE AREA
UNITS OF MEASURE
GEOMETRIC SHAPES
CENTER OF GRAVITY
FRACTION OPERATIONS
SCIENTIFIC FORMULA INTERPRETATION

SCIENCE CONCEPTS

BUOYANCY
SURFACE TENSION
CENTER OF GRAVITY
BONDING

Title: Dip Molding

Category: Processing

Description:

Dip molding is one of the major processes of the Plastic Industry. A mold is heated, then dipped into the liquid plastisol. Heat is applied curing the plastic into a solid. The mold is then cooled, depending on the finished product, the mold can be stripped away. Typical products produced by the dip molding process are spark plug covers, boots, coin purses, tool handles and dish drain racks.

Science Concepts:

1. Energy is the ability to do work; heat is an example.
2. The energy transferred between objects because of a difference in temperature is known as heat.
3. Conduction is the energy transfer through matter from particle to particle.
4. A mixture is two or more elements or compounds that are blended without combining chemically. An example of a mixture is a plastisol which is finely ground polyvinyl chloride resins and plasticizers.
5. Physical change is the change in size, shape or state without a change in composition.
6. Thermal pollution is when waste heat damages the environment by raising the temperature.

Title: Dip Molding

Category: Processing

Math Concepts:

1. Time
2. Temperature
3. Solving equations
4. Formulas

$$C = \frac{5}{9}(F-32)$$

$$F = \frac{9}{5}C+32$$

5. Order of operations
6. Fraction computation
7. Estimation of fractions
8. Collection of data
9. Develop a graph

DIP MOLDING

SCIENCE CONCEPTS

THERMAL POLLUTION

PHYSICAL CHANGE

CONDUCTION

ENERGY

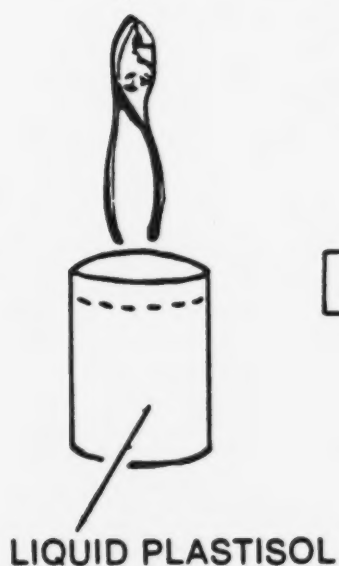
MATH CONCEPTS

TEMPERATURE

EQUATIONS

FORMULAS

TIME



HEAT

COOL



TITLE: The Drill Press

Area of Study: Process

DESCRIPTION:

How much easier does a machine make work for man? This transparency teaches how each simple machine has a mechanical advantage. Students can compute mechanical advantage through formulas derived from scientific principles and apply them to skills taught in technological/vocational education.

SCIENCE CONCEPTS:

Mechanical Advantage - Machines are used to give a certain advantage. The machine, simple or complex, multiplies the amount of force applied. This gain in force is called the machines mechanical advantage. This value is not always greater than one. Sometimes a gain in force is sacrificed for a gain in speed or a change in direction.

Ideal Mechanical Advantage - I.M.A.. The ideal mechanical advantage tells us how the machine can ideally change the force. Ideal means neglecting friction.

Actual Mechanical Advantage - A.M.A.. The actual mechanical advantage tells how a machine actually changes a force. It includes the effects of friction.

Friction - Friction, a force that opposes motion, decreases the mechanical advantage of a machine. It can slow down and wear out parts on a machine. Friction changes work to heat, reducing the amount of work done by the machine, thereby reducing the mechanical advantage of the machine.

Torque - The twisting or turning action that tends to produce a rotation is called torque. When applied to lever systems or beams the word "moment" is substituted. It is the product of the force applied to a turning object and the perpendicular distance from the center of rotation.

Inclined Plane - This sloping surface is used to move things from one level to a higher level. The inclined plane itself does not move when used, unlike other simple machines. The effort distance is the distance over which the object moves. (length of the ramp). This distance is divided by the resistance distance (height from ground to highest point of the ramp) The longer the effort distance the greater the mechanical advantage. The amount of work is not reduced but made easier.

Wedge - The wedge is similar to an inclined plane. Its two sides slope from a pointed end to a wider end. Unlike the inclined plane, the wedge moves when it is used. When effort is applied on the wedge it moves. This in turn moves the resistance.

DESCRIPTION:

How much easier does a machine make work for me? This transparency teaches how each simple machine has a mechanical advantage. Students can compute mechanical advantage through formulas derived from scientific principles and apply them to skills taught in technological/vocational education.

MATH CONCEPTS:

1. The inclined plane. To find the mechanical advantage of an inclined plane, you need to know two distances. One is the distance over which the object moves (the effort distance), and the height from the ground to the highest part of the inclined plane (the resistance distance). Dividing the effort distance by the resistance difference gives the mechanical advantage of the inclined plane.
$$MA = \frac{L(\text{length}) \text{ effort distance}}{H(\text{height}) \text{ resistance distance}}$$

2. The wedge is actually a double inclined plane. Thus, to determine the mechanical advantage of the machine, the length of the sloping surface is doubled. The formula

$$MA = \frac{L(\text{length})}{H(\text{height})} \times 2 \text{ is used.}$$

3. Torque (moment of force) is a change in rotational motion. It can be determined by both magnitude of a force and its moment arm.

$$\text{Torque} = \text{force (f)} \times \text{Moment arm (r)}$$

One must understand that r is measured perpendicular to the line of action of the force. The units of Torque are the units of force time distance (newton - meters (N-m) pound-feet (lb.ft)).

$$T = F \times D$$

MECHANICS OF SIMPLE MACHINES

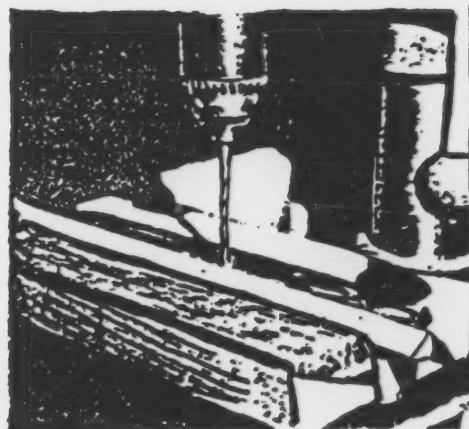
THE DRILL PRESS

M. A. - Mechanical Advantage

Inclined Plane

- a tapered surface
for lifting.

$$M. A. = \frac{L}{H} \begin{matrix} \text{(length)} \\ \text{(height)} \end{matrix}$$

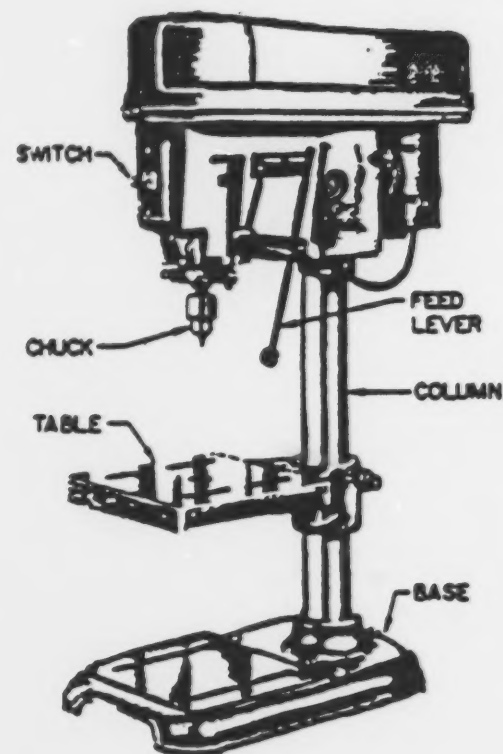


inclined plane
and
wedge

Wedge:

: a form of the inclined plane
with two sloping surfaces.

$$M. A. = \frac{L}{H} \begin{matrix} \text{(length} \times 2) \\ \text{(height)} \end{matrix}$$



TITLE: Drills

DESCRIPTION:

This transparency presents the identification of three basic drill bits and related concepts. Mathematical concepts include decimals, fractions, cutting speed, and angles. Science concepts include the inclined plane, the wedge, and friction. The sizing of drill bits and the relationship between friction and drill diameter complete the graphic display.

SCIENCE CONCEPTS:

1. A screw is an inclined plane wound around a cylinder
2. One complete revolution of a screw advances it the distance equal to the space between two successive threads.
3. As the bit turns against the material cut, friction occurs.
4. Friction produces heat which is a form of energy.
5. The faster the bit is turned the more friction occurs.
6. Depending on the material cut, heat produced by friction can be a problem
7. The harder the material cut the more friction occurs.
8. The greater the included angle the shorter the cutting edge. Therefore, the least friction occurs. The smaller the included angle the longer the cutting edge. Therefore, more friction occurs.
9. Friction is greatest when two surfaces begin to slide over each other. Overcoming inertia is the cause of this.
10. The larger the diameter of the bit the greater amount of friction occurs.
11. The wedge is a simple machine used as a cutting edge.

TITLE: Drills

DESCRIPTION:

This transparency presents the identification of three basic drill bits and related concepts. Mathematical concepts include decimals, fractions, cutting speed, and angles. Science concepts include the inclined plane, the wedge, and friction. The sizing of drill bits and the relationship between friction and drill diameter complete the graphic display.

MATH CONCEPTS

1. Included angle - Angle in degrees, formed by the taper of the drill point.
2. Diameter - The distance of a line through the center of the drill to the sides. Width of the drill determines hole size.
3. Speed - Turning speed of the drill measured in revolutions per minute (R.P.M.).
4. Cutting Speed - (CS). Distance in feet traversed in one minute by the outer corners of the cutting edges of the drill.
 $CS = \text{Circumference (C)} \times \text{R.P.M.}$
5. Degree - Unit of measure used to measure angles. One degree is $\frac{1}{360}$ of the entire angular measure about a point.
6. Taper - Difference between the diameter of the large end and the diameter of the small end.
 - A. Slow Taper - included angle of not more than 3°
 - B. Fast Taper - larger included angle.
7. Fractions - Division of a whole into parts.
 - A. Denominator - identifies number of parts.
 - B. Numerator - identifies number of parts being used.
8. Decimals - Form of fractions using the decimal point and place value, that has a denominator of 10 or a power of 10.

TITLE: Drills

RELATED VOCABULARY

1. Angle - The figure formed by two lines which come together at a point; also the space between two such lines.
2. Bit - A tool for boring or drilling that usually fits into a tool, called a brace.
3. Cutting edge - The sharpened point of the drill bit movement.
4. Cutting speed - Speed of a tool that passes over the work. Formula for cutting speed: $CS = c \times R.P.M.$, c = circumference in feet
5. Cylinder - Any long, round object, solid or hollow, with flat ends. A soda can is a cylinder in shape.
6. Decimal fraction - Fraction whose denominator is ten or some power of ten. Figures that appear to the right of the decimal point form the understood numerator. Examples: $\frac{1}{10} = .1$, $\frac{2}{100} = .02$
7. Degree - Unit for measuring angles on arcs. A circle has 360 degrees.
8. Diameter - The length of a straight line passing through the center of a sphere or circle.
9. Flute - A long round groove.
10. Fraction - One or more of the equal parts of a whole, $\frac{1}{2}$, $\frac{2}{3}$, $\frac{3}{4}$, $\frac{5}{6}$, and $\frac{7}{8}$ are a few examples of fractions.
11. Friction - The rubbing of one object against another.
12. Hardness - The hardness of a substance is measured by its ability to scratch other substances.
13. Inclined plane - A straight slanted surface.
14. Included angle - Angle formed by the taper of the drill.
15. Inertia - The tendency of all objects and matter to stay still, or if moving, to go on moving.
16. Revolution - Movement in a circle or curve around some point.
17. R.P.M. - Revolutions per minute.
18. Screw - A cylinder or cone-shaped object with a ridge winding around it.
19. Speed - Rate of movement
20. Spur - Point sticking out.
21. Taper - Make or become gradually smaller toward one end.
22. Twist drill - A spiral fluted tool with the tip ground to two cutting wedges, used in making round holes in wood and other materials.
23. Wedge - A movable inclined plane.

DRILLS

SIZE OF DRILL
DETERMINED BY DIAMETER

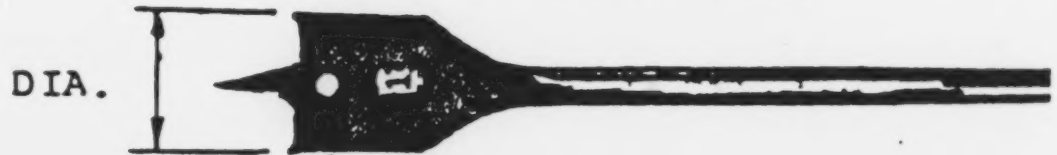
DIAMETERS GIVEN IN:
FRACTIONS $\frac{1}{4}$ "
DECIMALS .250 "
METRIC 2 mm
NUMBERS 0 - 60
LETTERS A - Z



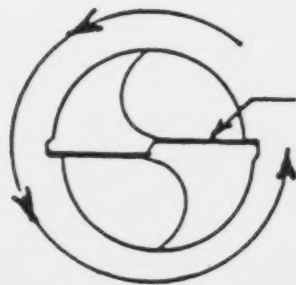
TWIST DRILL



AUGER BIT



POWER WOOD BIT



CUTTING EDGE
PRODUCES FRICTION

CUTTING SPEED

C.S. = CIRCUMFERENCE x R.P.M.

DRILLS



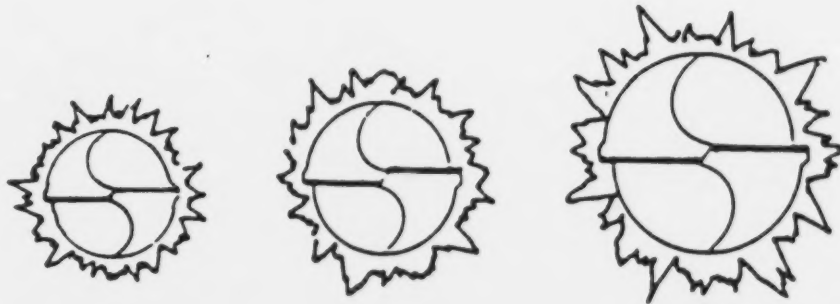
INCLUDED ANGLE



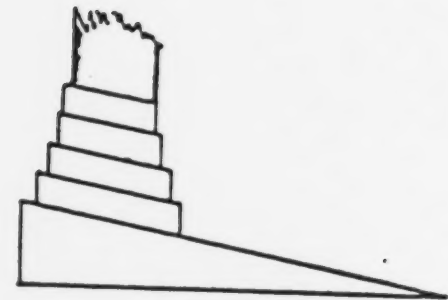
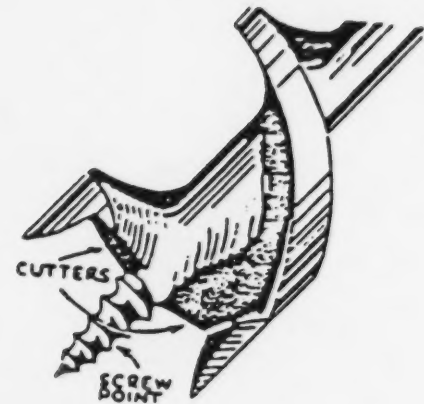
THE GREATER THE ANGLE THE
SHORTER THE CUTTING EDGE

THE SHORTER THE CUTTING EDGE
THE LESS FRICTION

FRICTION INCREASES



AS THE DRILL DIAMETER INCREASES
AND THE SPEED (R.P.M.) REMAINS CONSTANT



INCLINED PLANE

A SIMPLE MACHINE, APPLIED
AS A SCREW THREAD, TO PULL
THE AUGER BIT INTO THE WOOD

WEDGE

A SIMPLE MACHINE USED AS
THE CUTTING EDGE OF
ALL DRILLS

DRILLS



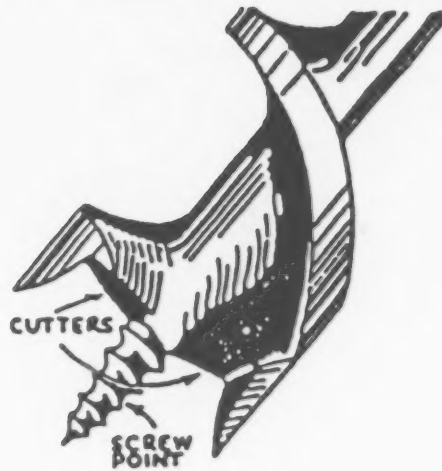
TWIST DRILL



AUGER BIT

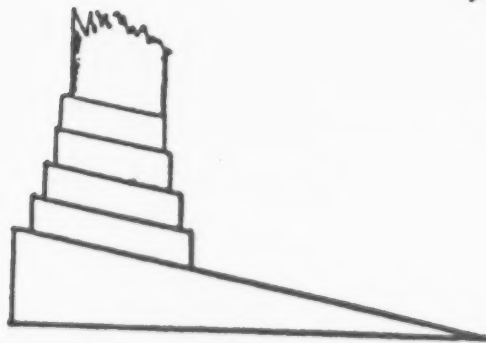


POWER WOOD BIT



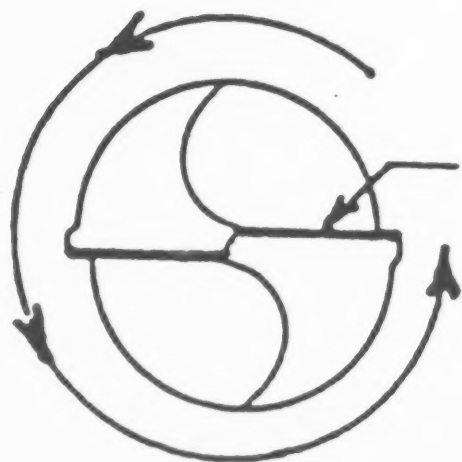
WEDGE

A SIMPLE MACHINE USED AS
THE CUTTING EDGE OF
ALL DRILLS



INCLINED PLANE

A SIMPLE MACHINE, APPLIED
AS A SCREW THREAD, TO PULL
THE AUGER BIT INTO THE WOOD



CUTTING EDGE
PRODUCES FRICTION

CUTTING SPEED

C.S. = CIRCUMFERENCE x R.P.M.



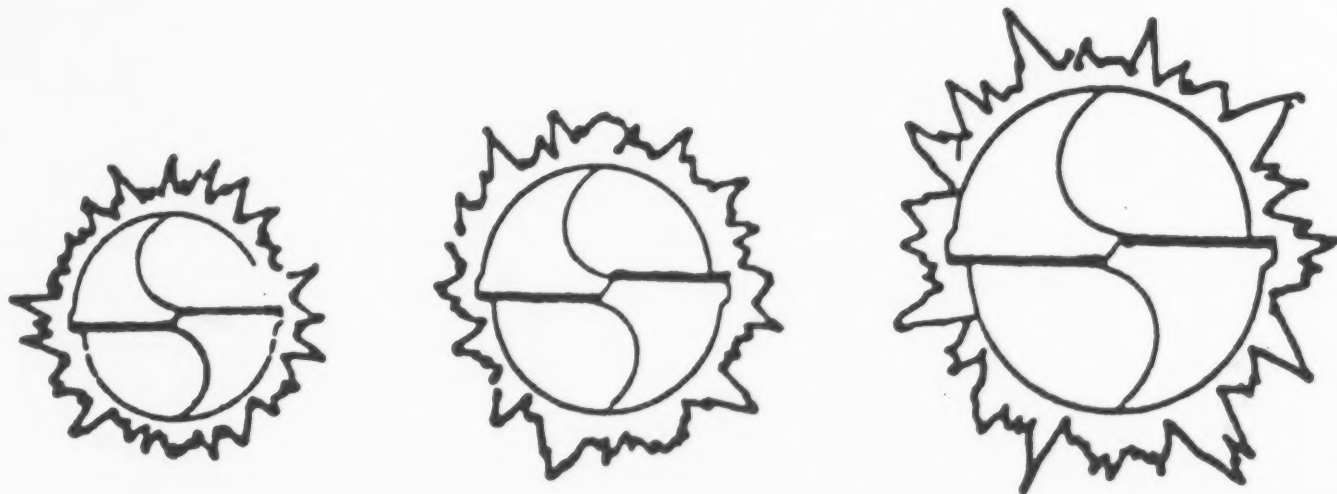
INCLUDED ANGLE



THE GREATER THE ANGLE THE
SHORTER THE CUTTING EDGE

THE SHORTER THE CUTTING EDGE
THE LESS FRICTION

FRICTION INCREASES



AS THE DRILL DIAMETER INCREASES
AND THE SPEED (R.P.M.) REMAINS CONSTANT

Title: Electric Spot Welding

Category: Process

Description:

Electric spot welding is a form of resistance welding. Spot welding is done by passing high current at a low voltage through a small spot on two pieces of sheet metal.

Resistance to the flow of current through the metal at the spot causes heat which makes the spot weld. The pieces of metal must be held together under moderate pressure during the weld and for a few seconds while the weld cools.

Science Concepts:

1. There are three states of matter: gas; liquid; solid.
2. Some substances can change from one state to another.
3. All substances are made from atoms.
4. Most atoms have electrons.
5. Electrons can be caused to flow.
6. Resistance to the flow of electricity can cause heat.
7. Heat can cause many solids to soften.
8. Some substances can be fused when heated.

Title: Electric Spot Welding

Category: Process

Math Concepts

1. Ohm's Law. $R = \frac{E}{I}$

where I = amperes
E = volts
R = resistance

2. Computing electrical power. $W = I \times E$

Where W = watts
I = amperes
E = volts

3. Computing work that electricity can do.

work = watt - hours

4. Solving equations.

5. Measurement of distances between spot welds.

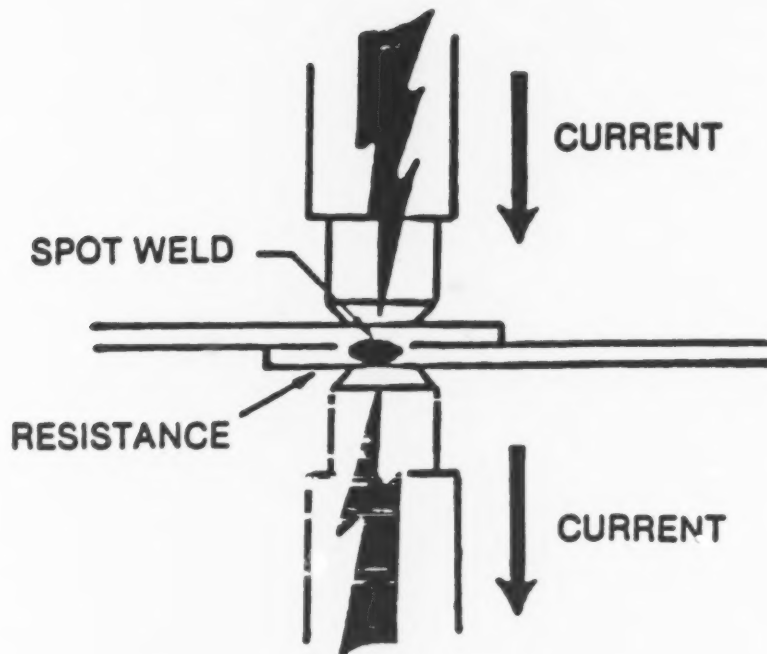
6. Division of fractions and/or decimals to equally space spot welds.

7. Reading charts to determine gage and thickness of steel to be welded.

This will involve comparing decimals and understanding decimal place value through ten-thousandths.

ELECTRIC SPOT WELDING

(RESISTANCE WELDING)



MATH CONCEPTS

OHM'S LAW

$$R = \frac{E}{I}$$

ELECTRICAL POWER

$$P = I \times E$$

SCIENCE CONCEPTS

RESISTANCE CAUSES HEAT

HEAT CAN FUSE METALS

Title: Injection Molding

Description: Injection molding is accomplished by forcing or squeezing a semi-fluid or plasticized thermoplastic into a mold cavity where it cools to form an article.

Math Concepts:

Basically the mathematics involved has to do with the equations which control the various processes involved.

1. First the pneumatic plunger operates by air pressure. The work done by the gas to force the piston to push the material is determined by

$$P = \frac{F}{A} \quad \text{Pressure} = \text{force/area}$$

$$d w = F dx \quad \text{force distance}$$

$$= P \cdot A Dx$$

$$w = P \cdot A Dx \quad \text{but } d_v = A dx$$

$$w = p.v$$

2. The volume of the fluid flowing in to seconds down a pipe as given by

$$V = \frac{p r^4 t}{8 L z} \quad \text{where}$$

$$V = \frac{PR^4 t}{8 L z}$$

p is density

r radius of pipe

t time of flow

L length of pipe

z viscosity of the fluid

$$\text{where } z = \frac{Fd}{Av}$$

When fluids are in motion, there is evidence of internal friction, called viscosity. Force is required to drive a liquid through a pipe. The layer of fluid at the walls is supposed to remain at rest as the adjacent layer flows along, it experiences a frictional resistance. The friction of one layer of fluid upon another depends on the nature and temperature of the fluid. The viscosity of the fluid z is defined as frictional force per unit area of a fluid that is flowing with velocity v parallel to a stationary layer separated by a distance "d" the intervening space being filled with the fluid.

$$z = \frac{F/A}{v/d} = \frac{Fd}{Av} \quad \frac{\text{dyne sec}}{\text{cm}^2}$$

The volume of liquid which flows per second through a horizontal tube of radius R and length l under constant difference of pressure P between the two ends is inversely proportional to the coefficient of viscosity of the fluid.

3. The viscous Fluid Velocity with radius of fluid flowing in pipe with "a" at a distance from the axis is given by

$$v = \frac{P_1 - P_2}{4 \mu L} (a^2 - R^2)$$

$$r = l$$

where P_1 high pressure

P_2 low pressure

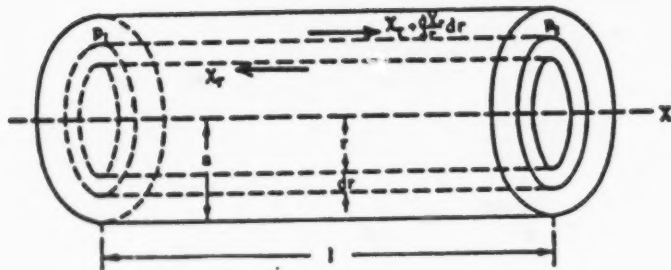
l length of pipe

a radius of pipe

μ coefficient of viscosity

R radius

of shell of fluid



4. The difpesinity of temperature can be give by

$$k = \frac{k}{\rho c} \quad \text{where } K \text{ Thermal conductivity}$$

C - Specific heat of the material

D - Density of the material

"k" is the rate at which a temperature wave travels through a material

5. Heat energy produced by an electric current for a time is given by

$$A = EIT$$

where E - Voltage (valls)

I - Current (amps)

T - Time (secs)

This describes the operation of the heating wires.

6. The rate at which a material or fluid cools is given by

$$T = T_o e^{-at}$$

where T_o initial temperature

T - final temperature

a - constant of proportionality

t - time

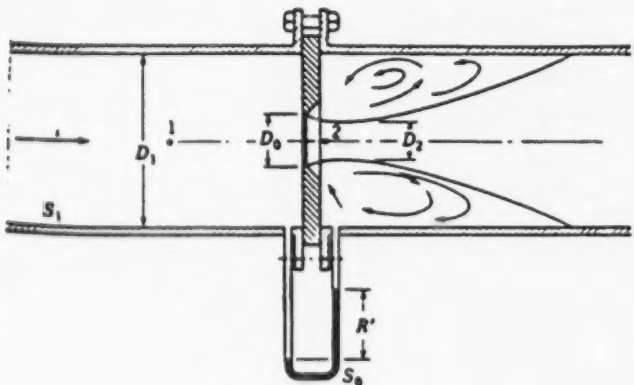
7. The drag on the immerse object the torpedo is given by

$$D = C_D A_P \frac{U^2}{2} \quad \text{where } C_D \text{ constant} = 0.6 \text{ for elliptical cylinder}$$

A - projected area of the body on a plane normal to flow U - velocity of the fluid

8. The velocity at the orifice in a pipe is given by

$$v = C_v \sqrt{\frac{2 (P_1 - P_2) / \rho}{1 - C_c^2 (D_o/D_1)^4}}$$



Where C_v - velocity coefficient

A_o - Cross sectional area of the orifice

C_c - Contraction coefficient

D_o - Diameter of the orifice

D_1 - Dia of the pipe

$C_c A_o$ - Area of the jet

$$C_d = C_c \cdot C_v$$

9. The discharged material is given by $Q = C_d A_o$

$$v = \sqrt{\frac{2 (P_1 - P_2) / \rho}{1 - C_c^2 (D_o/D_1)^4}}$$

Title: Injection Molding:

Science Concepts:

Heat Transfer - Thermal energy is applied to the Thermoplastic material by electric heating elements in the heating cylinder. The thermal energy is conveyed equally through the material by means of a Torpedo in the main cylinder.

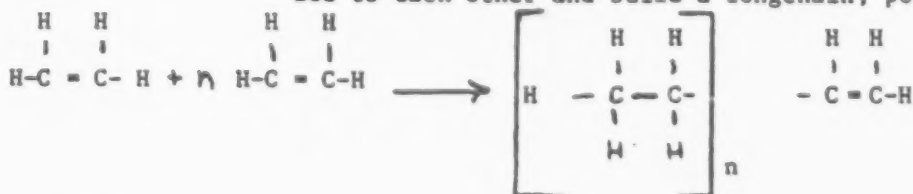
Compressed Air (Pneumatics) - Compressed air is used to power the cylinder and ram, which actually pushes the thermoplastic material into the mold. Air is compressed when a larger number of molecules than would normally be there are forced into a definite volume. As the number of molecules increases in a fixed volume the pressure of the gas increases and if the piston is allowed to move in the cylinder the increased pressure will cause the piston (RAM) to move.

Pressure - Pressure in a confined gas is a result of the molecules of gas exerting force on the area they impact. As the number of molecules increases the number of collisions increases and there is a greater force on the same area therefore the pressure increases.

Polyethylene - A polymer made by addition of ethene (ethylene) monomers. The monomer units can be represented by C_2H_4 or $\begin{array}{c} H & H \\ | & | \\ H-C & = & C-H \end{array}$.

This compound, e then e , (ethylene) is an unsaturated hydrocarbon, which means that it contains a double bond between carbon atoms.

Under the proper conditions the ethene (ethylene) molecules add to each other and build a longchain, polyethylene.



INJECTION MOLDING

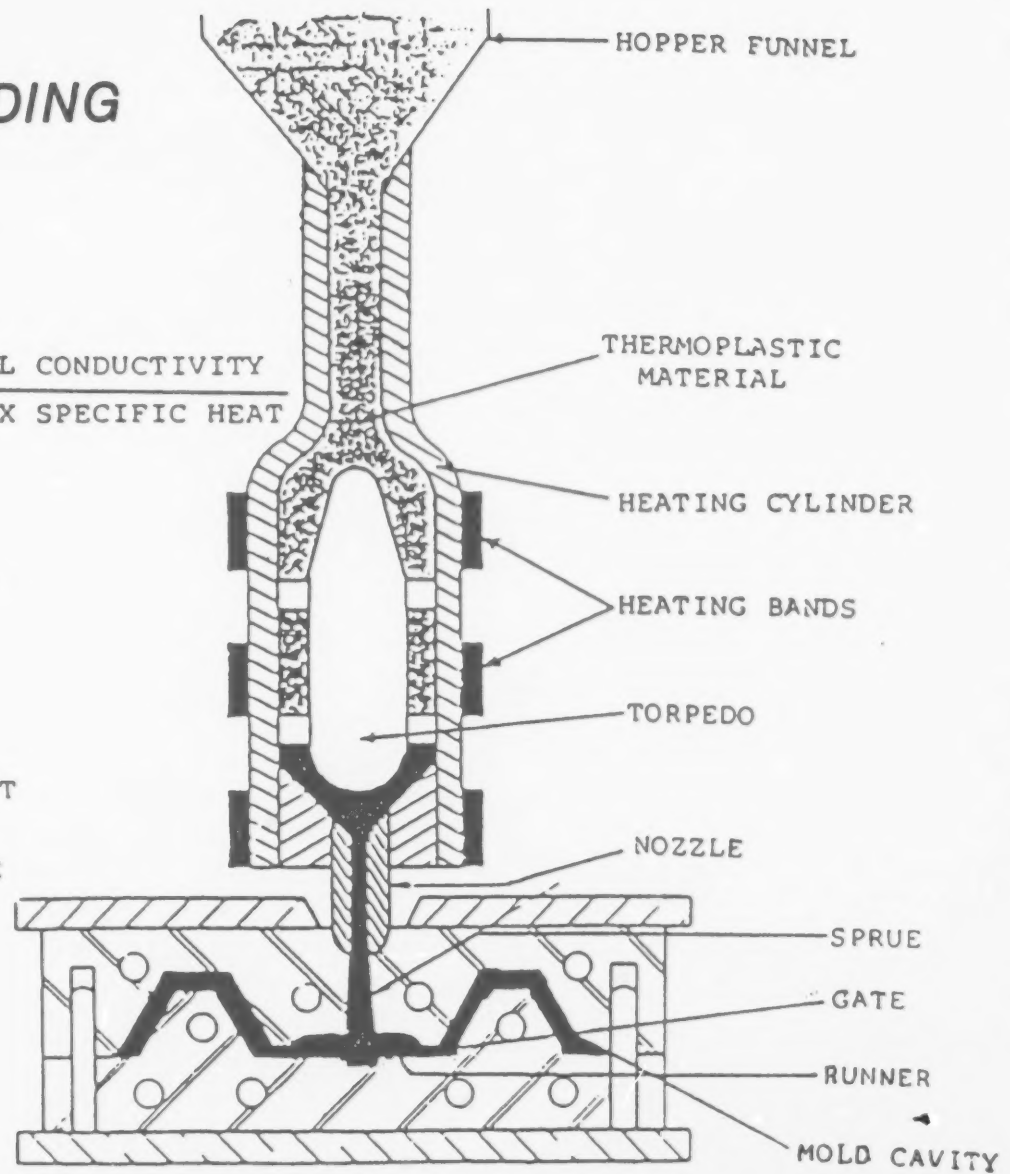
DIFFUSION OF TEMPERATURE = $\frac{\text{THERMAL CONDUCTIVITY}}{\text{DENSITY X SPECIFIC HEAT}}$

$$k = \frac{K}{\rho c}$$

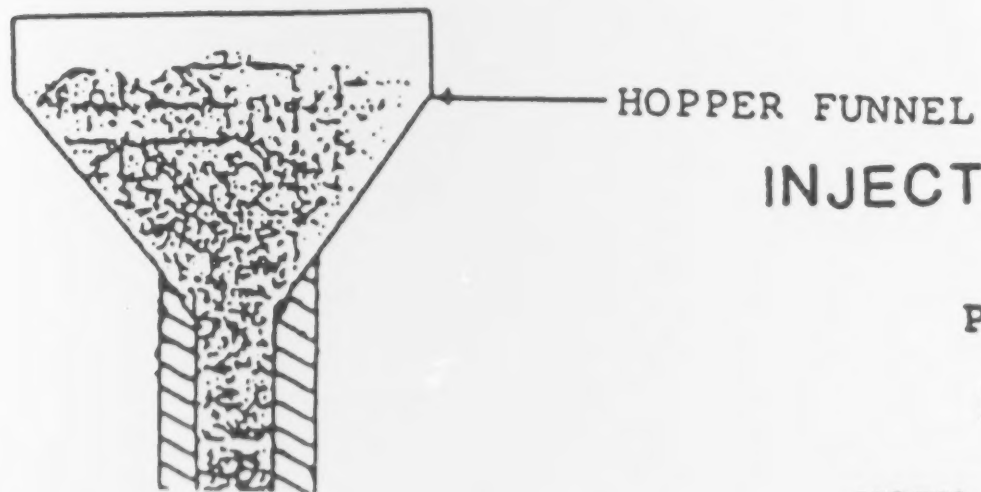
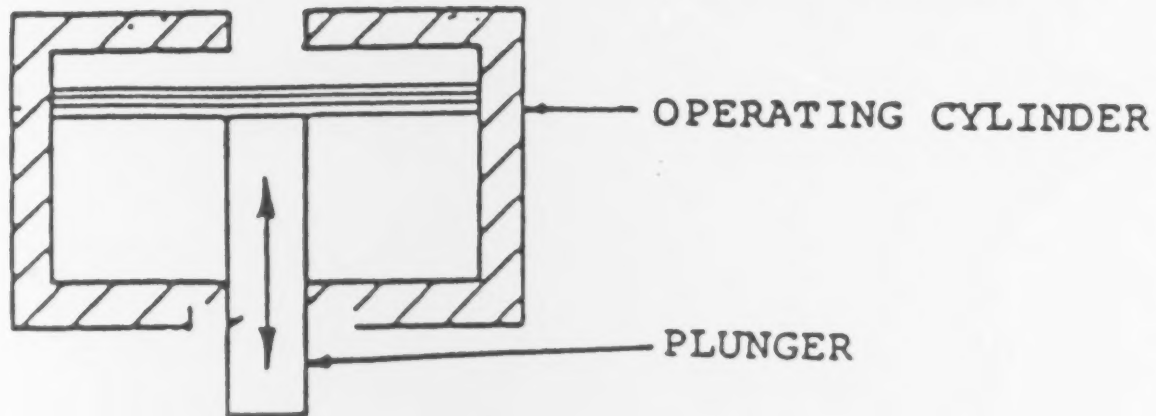
POLYMERIZATION

VOLUME BY DISPLACEMENT

VOLUME BY DIFFERENCE



INJECTION MOLDING



INJECTING

PNEUMATICS

DENSITY

WORK = PRESSURE X VOLUME

$W = PV$

TITLE: THE JIG SAW

CATEGORY: MACHINE

DESCRIPTION:

The jig saw is one of the simplest and safest machines for cutting wood. It is used to cut curves and shapes, both internal and external. The blade is inserted in the saw with the teeth pointing downward, and can vary in size and shape depending upon the type of cut desired. The jig saw is also commonly called the scroll saw.

SCIENCE CONCEPTS:

1. Work is the product of a force and the distance through which motion takes place in the direction of the force.
2. Energy is the ability to produce work.
3. Mechanical energy is a kind of energy produced whenever a force is applied to an object and the object moves in the direction of the applied force.
4. Potential energy is the form of energy available to do work that an object has because of its position or condition.
5. Kinetic energy is the form of energy available to do work that an object has because of its motion.
6. Power is the time rate of doing work.
7. A machine is a device used for multiplying or transferring an applied force.
8. Angular velocity is the angular distance through which an object rotates in some time interval, divided by that time interval.
9. Linear speed is the distance an object travels in one minute.
10. The thermal coefficient of linear expansion is the change in length of an object, per unit length (in./in. or mm/mm), for each degree of temperature change (F or C).
11. Efficiency is the ratio of useful work gotten out of a machine compared to the work put into a machine.
12. Tensile force is an external force that creates a pulling or stretching action on a material.
13. Hooke's Law is the deformation of an object directly proportional to the applied force.
14. Ultimate strength is the maximum stress value that a material can withstand.

SCIENCE CONCEPTS CONTINUED:

15. Ductility is a measure of the plasticity of metals.
16. Hardness is the ability of a material to resist scratching or denting.

MATHEMATICAL CONCEPTS:

1. Linear measurement

2. Decimals

3. Charts and Graphs

4. Equations

5. Formulas:

A) work

$$W = F D$$

B) potential energy

$$PE = w \times H$$

C) kinetic energy

$$KE = \frac{1}{2} m V^2$$

D) power

$$P = \frac{W}{T}$$

E) linear speed

$$V = 2 \pi R N$$

F) linear expansion

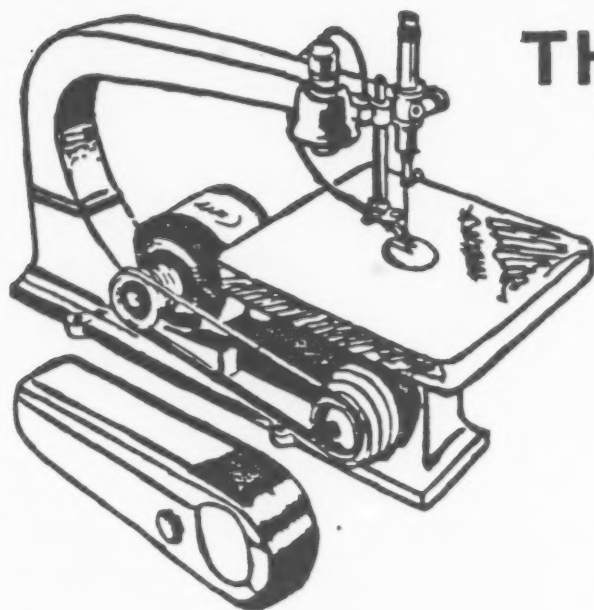
$$L = \alpha \times L \times T$$

G) stress

$$S = \frac{F}{A}$$

H) Hooke's Law

$$e = \frac{\Delta L}{L}$$



THE JIG SAW

THE JIGSAW IS USED
TO CUT CURVES AND
SHAPES, BOTH INTERNAL
AND EXTERNAL.



SCIENCE
WORK
ENERGY.
POWER
EFFICIENCY



MATH
EQUATIONS
DECIMALS
LINEAR MEASUREMENT
CHARTS & GRAPHS

Title: Laser Drilling/Welding

Category: Innovation

Description:

1. The laser was invented by C.H. Townes and Arthur Schawlow in 1958.
2. Laser is the abbreviation for Light Amplification by Stimulated Emission of Radiation.
3. The laser produces a very narrow intensive beam of light that can be focused on a spot that is very small in diameter.
4. The laser produces heat of over 7500°F.
5. The laser can be roughly compared to using a magnifying glass to direct the rays of the sun onto wood to start a fire.
6. By using a convex lens, a laser beam can be concentrated on a small point and used for cutting and drilling.
7. All types of materials (metals, wood, plastic, rubber, and cork) can be cut with the laser beam to very precise designs.
8. Laser cutting can be so sharp, the edges don't have to be filed or buffed.
9. The laser is used for drilling materials which cannot be drilled by any other method.

Example: diamond drilling

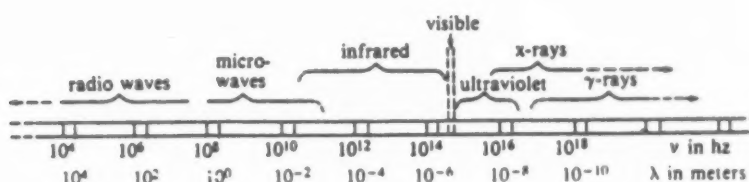
10. In pulsed-laser welding, the energy of a laser light beam is focused at the area to be welded. With each pulse, the workpiece is moved to refocus the light one-half spot away.
11. Laser welding can be done on difficult joints and small electronic materials and through glass or plastic.

Title: Laser Drilling/Welding

Category: Innovation

Science Concepts

1. Light is composed of tiny packets of energy called photons.
2. The photons move in a wavelike pattern.
3. Visible light is part of a larger electromagnetic spectrum consisting of: cosmic rays, gamma rays, x-rays, ultraviolet, visible light, infrared and microwaves.



4. The various portions of the electromagnetic spectrum differ in wavelength.
5. Wavelength is the distance from the peak of one wave to the peak of the next.
6. Wavelength = velocity/frequency
7. Light from the sun or an incandescent light is polychromatic (many colors) and is radiated in all directions. It is incoherent.



8. Laser light is monochromatic and all waves are moving in parallel paths. It is coherent.

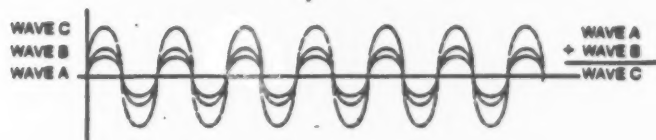


Title: Laser Drilling/Welding

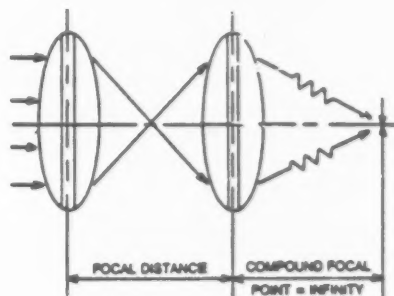
Category: Innovation

Science Concepts

9. When coherent light passes through an excited or energized material, it stimulates the emission of more photons of the same wavelength.
10. These new photons are also in phase and are additive.



11. A convex lens or series of lens are used to refract (bend) the light emitted by the laser to concentrate the light energy.



Title: Laser Drilling/Welding

Category: Innovation

Math Concepts

1. Exponents are an easy way to write very large or small numbers.

Example: $5^2 = 5 \times 5 = 25$
 ↑ exponent (tells how many times the base is used as a factor)
 ↓
 base (factor)

This is read "five to the second power"
or
"five squared"

Example: $4^3 = 4 \times 4 \times 4 = 64$

This is read "four to the third power"
or
"four cubed"

2. Multiplying by powers of 10

Positive Exponent - move the decimal point to the right as many times as the exponent tells you

Example: $1.25 \times 10^4 = 12500$
 →

Negative Exponent - move the decimal point to the left as many times as the exponent tells you.

Example: $1.25 \times 10^{-4} = .000125$
 ←

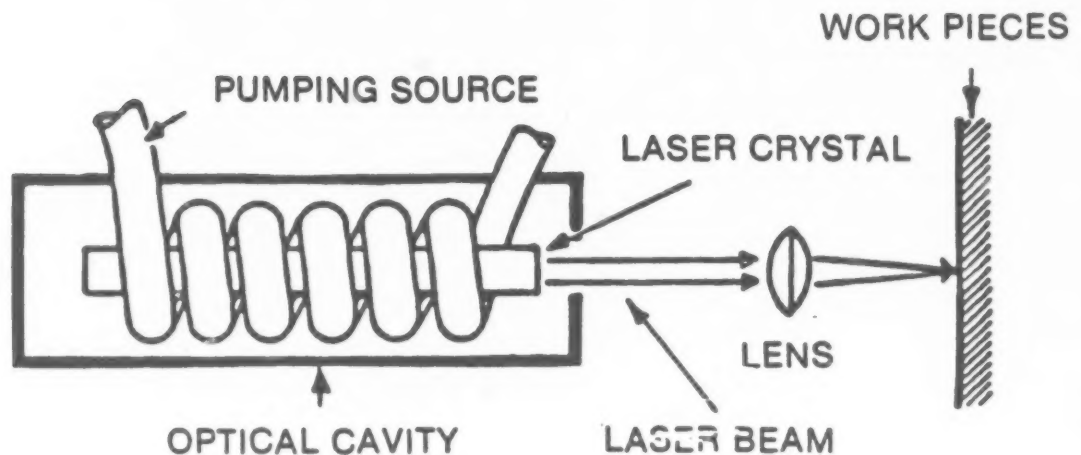
3. Wavelength (λ) is the distance covered by one cycle.

$$\lambda = \frac{\text{velocity}}{\text{frequency}}$$

4. The focal length (f) is defined as the object distance of a point on the lens axis whose image is at infinity. "S" is the distance between the object point and the spherical surface. "S'" is the distance between the spherical surface and the image.

$$1/f = 1/s + 1/s'$$

LASER DRILLING/WELDING



DRILLING: THE LASER BEAM PASSES THROUGH A CONVEX LENS, STRIKES THE WORK PIECE AND PRODUCES A PRECISE HOLE.

WELDING: THE PULSATING LASER BEAM PASSES THROUGH A CONVEX LENS, STRIKES THE SLOW MOVING WORKPIECE AND PRODUCES A PRECISE WELD.

TITLE: Lathe Cutting Speeds

DESCRIPTION:

The accuracy and wearability of mating surfaces are directly proportional to the surface finish produced. The surface finish is produced by a cutting tool and its interaction with the crystal structure of the workpiece.

The tool pressure causes stress within the crystals. The compression, elongation, and ultimate rupture of the crystals releases heat which must be dissipated through the workpiece and the cutting tool. This heat must be reduced by lubrication and controlling the cutting speed.

SCIENCE CONCEPTS:

1. Crystal elongation is the distortion of the crystal structure of the work material which occurs during a machining operation.
2. The deformed zone is the area in which the work material is deformed during a cutting action.
3. Plastic deformation is the deformation of the work material occurring in the shear zone during a cutting action.
4. Plastic flow is the flow of metal occurring on the shear plane which extends from cutting tool edge to the corner between the chip and the unmachined work surface.
5. A rupture is the tear that occurs when brittle materials, such as cast iron, are cut and the chip breaks away from the work surface. This generally occurs when discontinuous or segmented chips are produced.

TITLE: Lathe Cutting Speeds

DESCRIPTION:

The purpose of this lesson is to use lathe cutting speeds for aluminum to calculate the spindle speed of the workpiece. The student will need:

1. to determine the cutting speed for aluminum from a chart.
2. to measure the aluminum piece to find its diameter.
3. to find the spindle speed of the workpiece given the above information.

MATH CONCEPTS:

1. Transposing Formulas:

Given the formula for cutting speed, transpose it into a formula for spindle speed.

$$CS = \frac{\text{diameter} \times \text{r.p.m.}}{4}$$

where CS = cutting speed, r.p.m. = spindle speed of workpiece, and diameter = diameter of aluminum piece

$$\text{r.p.m.} = \frac{CS \times 4}{\text{diameter}}$$

2. Calculate spindle speed:

$$\text{r.p.m.} = \frac{CS \times 4}{\text{diameter}}$$

Example: An aluminum workpiece with a 2" diameter

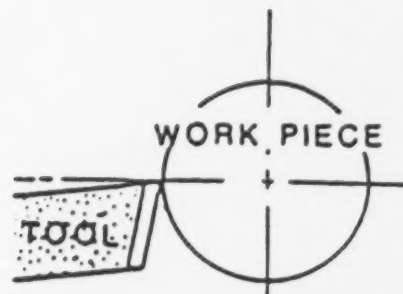
1. Find the cutting speed.:
from chart, CS = 200
2. Find spindle speed.

$$\text{r.p.m.} = \frac{200 \times 4}{2} = \frac{800}{2} = 400$$

LATHE CUTTING SPEEDS



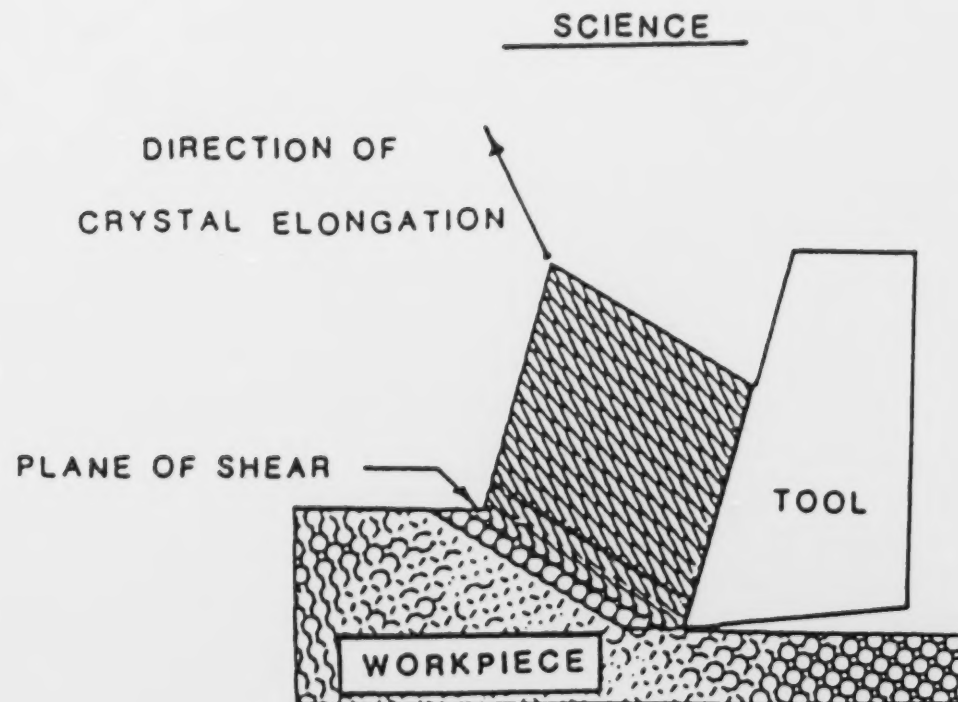
SELECT A SPEED FOR EFFICIENT CUTTING
AND MAXIMUM TOOL LIFE.



MATH

$$\text{CUTTING SPEED} = \frac{\text{DIAMETER OF MATERIAL} \times \text{SPINDLE SPEED}}{4}$$

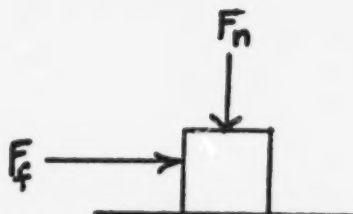
LATHE CUTTING SPEEDS



TITLE: Student Worksheets: Micrometer

DESCRIPTION: The micrometer is a device used for precision measuring. The mathematical and scientific concepts which govern the construction and operation are detailed.

FRICTION



$$F_f = K \cdot F_n$$

Friction is the resistance to motion. Sliding friction is important with this type of micrometer because of the spring on the ratchet stopshaft. When the ratchet stop cover is rotated the spring, which is gripping the ratchet stopshaft, causes the shaft to rotate and move the spindle closer to the anvil. When the force applied to the ratchet stop spring is great enough to overcome the friction between the spring and the shaft, the spring will revolve about the shaft and the shaft will not move. This will occur when the spindle is against the object.*

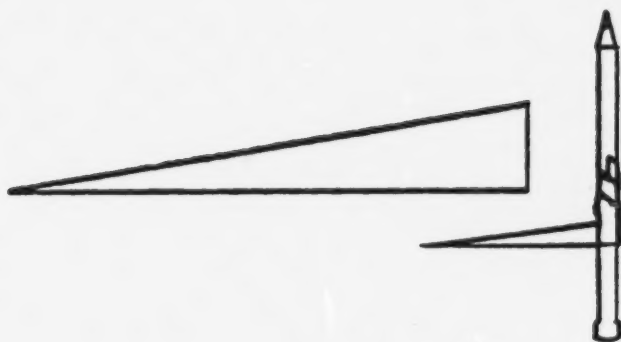
This also works like a person's hand on a screwdriver. When the screw is being turned into the material the shaft of the screwdriver is rotating because the hand, like the spring of the ratchet stop, is gripping the screwdriver and force is applied. When the screw is in as far as it will go the shaft of the screw driver stops turning and any added force by the hand will cause the hand to revolve about the screwdriver.

***RELATED VOCABULARY**

- | | |
|-------------|----------------------|
| 1. force | 8. resistance |
| 2. angle | 9. spring |
| 3. stop | 10. grip |
| 4. rotate | 11. spindle |
| 5. revolve | 12. anvil |
| 6. friction | 13. object |
| 7. shaft | 14. sliding friction |

TITLE: Student Worksheets: Micrometer

INCLINED PLANE



In the micrometer the concept of the inclined plane, as a screw, is used. The inclined plane occurs in the form of a threaded shaft which is called the spindle.

The thread of a screw is really an inclined plane wound around the rod. The longer the rod's plane the more threads it has (see drawing).

In the micrometer the inclined plane is not used to make it easier to do work, rather it is used as a precise way of measuring distance. (see Math Concepts section for discussion.)

RELATED VOCABULARY

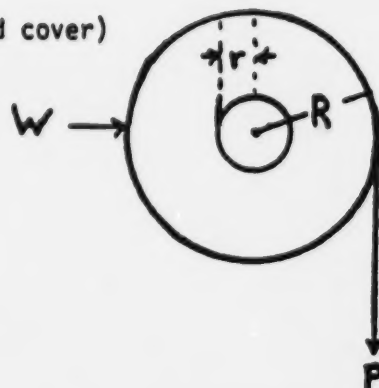
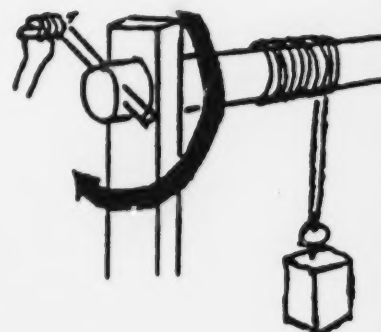
- | | |
|------------|------------|
| 1. thread | 5. measure |
| 2. screw | 6. slope |
| 3. incline | 7. angle |
| 4. plane | 8. ramp |

WHEEL AND AXLE



$$P \cdot R = W \cdot r$$

- P = force on wheel (cover)
R = radius of wheel (cover)
W = work to be done (turn the shaft and cover)
r = radius of shaft



TITLE: Student Worksheets: Micrometer

The concept of wheel and axle is evident in the micrometer.. When the ratchet stop cover is rotated the fingers supply the force (P) which is great enough to cause the cover and shaft to be turned.

RELATED VOCABULARY

- | | |
|---------------|-------------------------|
| 1. power arm | 4. force |
| 2. weight arm | 5. mechanical advantage |
| 3. radius | 6. work |

Micrometer Math Concepts

Data 40 threads per inch

$$p = \frac{1}{n}$$

$$= \frac{1}{40} = .025"$$

n = # of threads

h = depth of thread

p = pitch-distance
between thread
crests

Sharpe V Thread

$$h = \frac{0.8660}{n}$$

30, 60, 90 Right
triangle

$$h = \frac{b}{z} = .8660 \cdot b$$

If b = 1 thread base or 1 unit then h = .8660

$$\text{For } n \text{ threads } h = \frac{.8660}{n} = \frac{.8660}{40} = .02165"$$

TITLE: Student Worksheets: Micrometer

Micrometer Math Concepts (continued)

To convert fractions to decimals

Rule: Divide numerator by denominator

Example: $1/8 =$

Divide 8 into 1.0000 and round to nearest .001"

To convert decimals to fractions

Rule: 1. Write decimal over 1 in fraction form.

2. Multiply numerator and denominator by the power of 10 to make the decimal a whole number.

3. Reduce to simplest form

Example: .375 =

$$1. \frac{.375}{1}$$

$$2. \frac{.375}{1} \times \frac{1000}{1000} = \frac{375}{1000}$$

$$3. \frac{375}{1000} = \frac{15}{40} = \frac{3}{8}$$

To measure with the micrometer

1) The object is placed between the anvil and spindle and the jaws are closed until the ratchet stop overcomes the inherent friction and turns while the thimble remains at rest.

2) The horizontal scale on the sleeve is read first in the following manner:

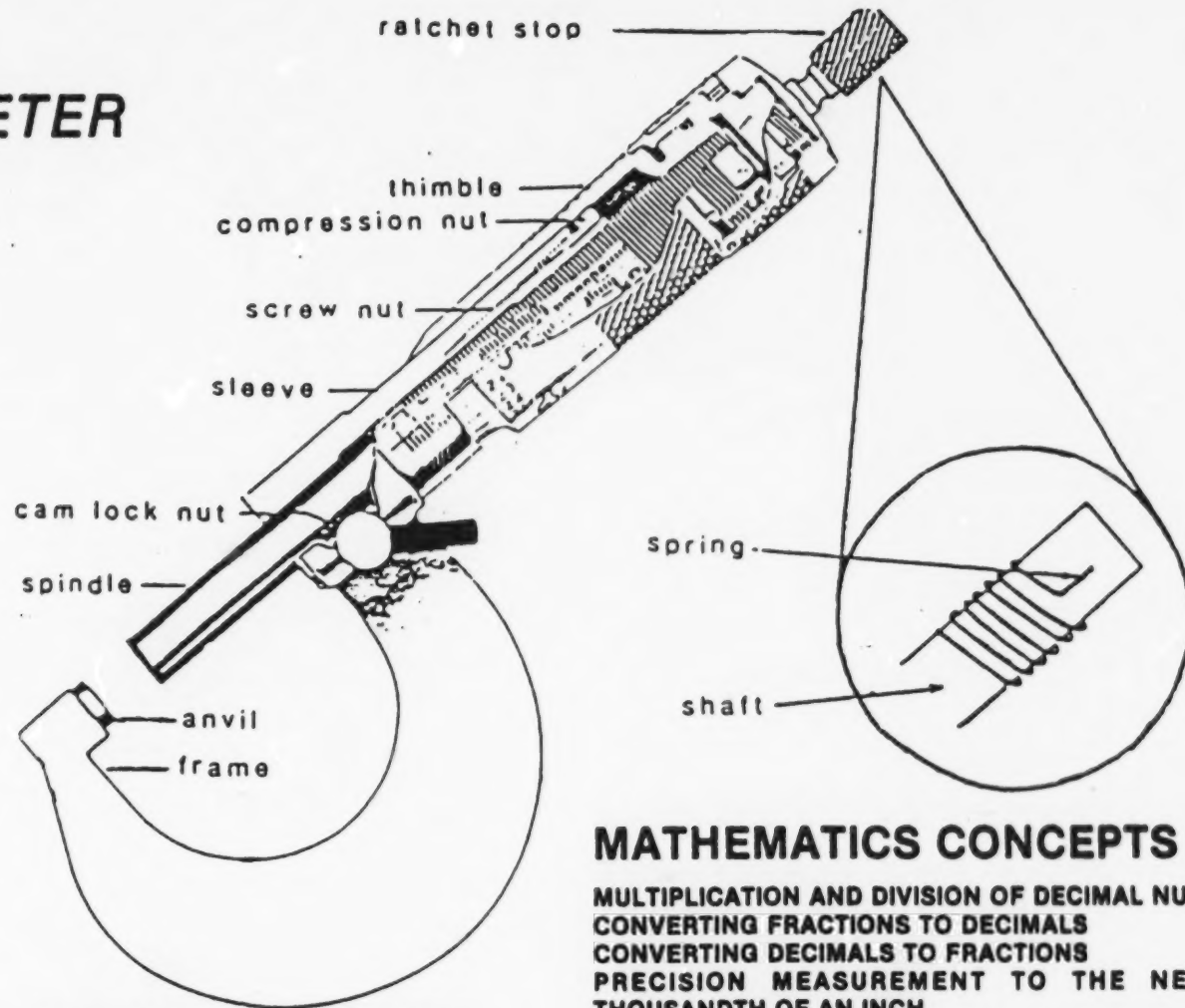
i) Read the largest exposed integer as a tenth value.
Example: 5 would be read 1.5

ii) Add to this reading .025" for each line or division past the integral measurement which can be seen.

iii) The second part of the measurement comes from the thimble. Each division is .001", so add the number of thousandths indicated on the thimble.

Example:

MICROMETER

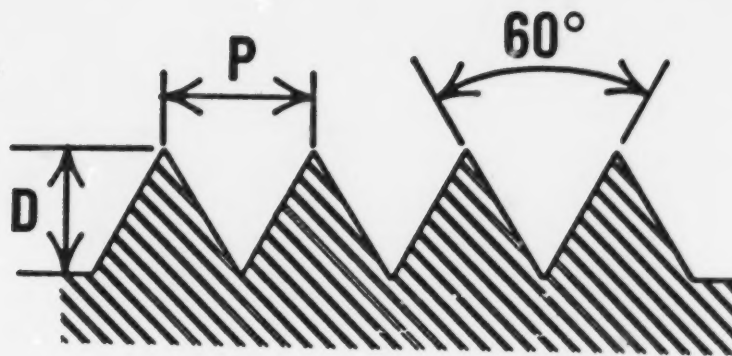


SCIENCE CONCEPTS

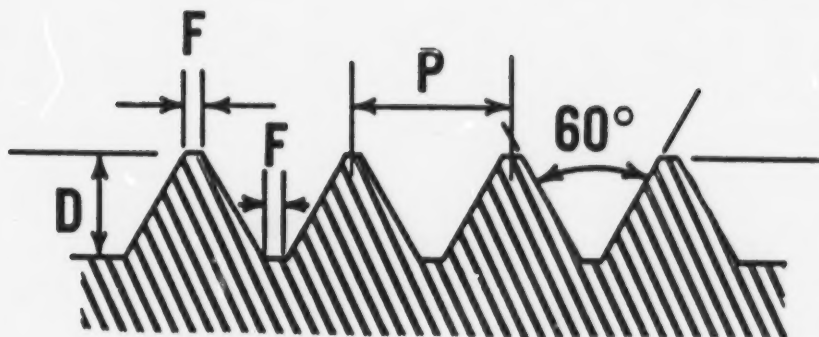
FRICTION
WHEEL AND AXLE
INCLINED PLANE
MEASUREMENT

MATHEMATICS CONCEPTS

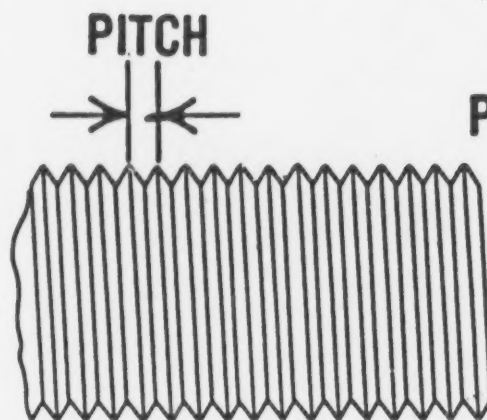
MULTIPLICATION AND DIVISION OF DECIMAL NUMBERS
CONVERTING FRACTIONS TO DECIMALS
CONVERTING DECIMALS TO FRACTIONS
PRECISION MEASUREMENT TO THE NEAREST
THOUSANDTH OF AN INCH
ESTIMATION OF A READING TO THE NEAREST TEN
THOUSANDTH OF AN INCH
USE OF A SPECIAL RIGHT TRIANGLE TO CALCULATE
THREAD DEPTH



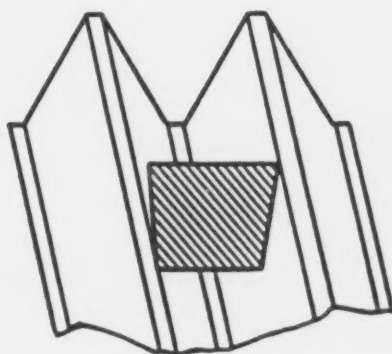
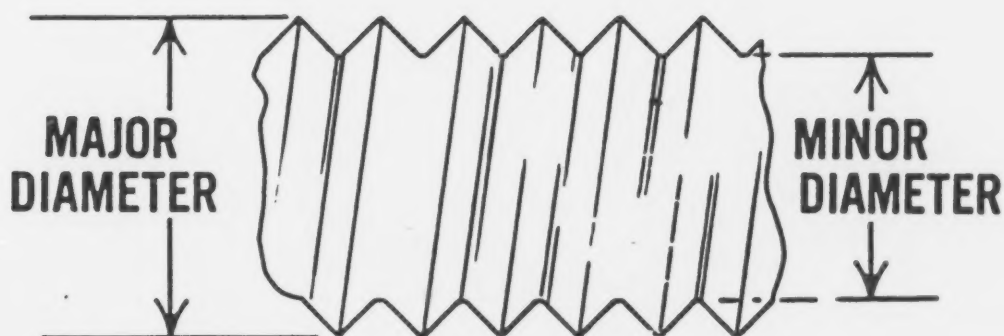
60° "V" THREAD



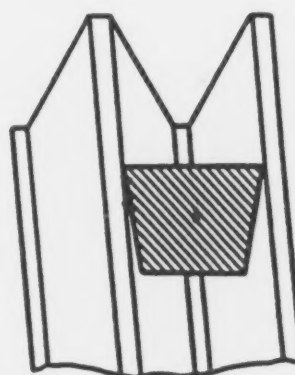
AMERICAN NATIONAL OR NATIONAL FORM THREAD



$$\text{PITCH} = \frac{1}{\text{NUMBER OF THREADS PER INCH}}$$



OK



TIGHT

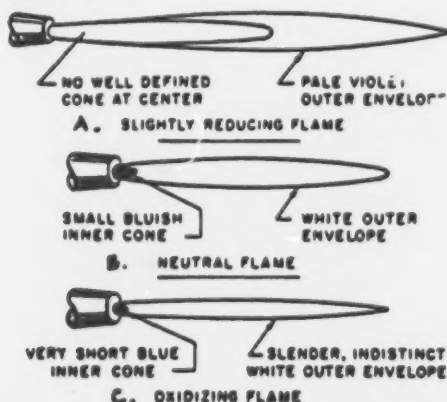
TITLE: The Oxygen Acetylene Torch

DESCRIPTION:

Acetylene is the most popular gas to use with oxygen for welding because of its high heat and wide availability. The molecular structure, having a triple, carbon to carbon bond, stores a large quantity of energy which is released as heat upon oxidation.

SCIENCE CONCEPTS:

1. Acetylene (actually "ethyne") is C_2H_2 .
2. Structurally: $H - C \equiv C - H$ where the $C \equiv C$ triple bond has a heat storage capacity of 312 KCal. (624 since there are 2 in C_2H_2)
3. Three types of flames are:

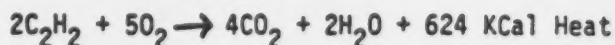


"A" + "B" are acceptable but "C" provides excess O_2 which forms oxides (e.g. Al_2O_3 , Fe_2O_3) which are detrimental to the weld.

4. Oxidizing flames ("C" above) are useful for cutting metals.
5. Regulating the ratio of O_2 to acetylene changes the characteristics of the flame.

$$6. \frac{P_1}{P_2} = \frac{\text{pressure of } O_2}{\text{pressure of } C_2H_2} = \frac{5}{2}$$

due to the oxidation formula:



TITLE: The Oxygen Acetylene Torch

DESCRIPTION:

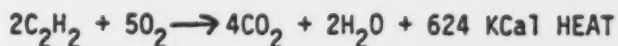
The purpose of this lesson is to explain the mechanics of the oxygen acetylene torch. The student will understand that the ratio of the pressures of oxygen and acetylene is five to two, a derivation is given. The student will use various ratios of pressures to test the above concept.

MATH CONCEPTS:

1. Dalton's Law of Partial Pressure:

$$\frac{P_1}{P_2} \quad \text{where } P_1 = \text{pressure of oxygen and } P_2 = \text{pressure of acetylene}$$

2. Oxidation Equation:



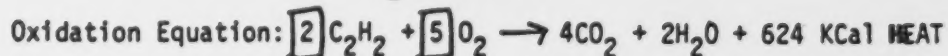
where C_2H_2 = acetylene, O_2 = oxygen, CO_2 = carbon dioxide, and H_2O = water.

3. Ratio of the pressures of oxygen to acetylene:

Using Dalton's Law of Partial Pressure and the molar coefficients of acetylene and oxygen from the oxidation equation we can conclude:

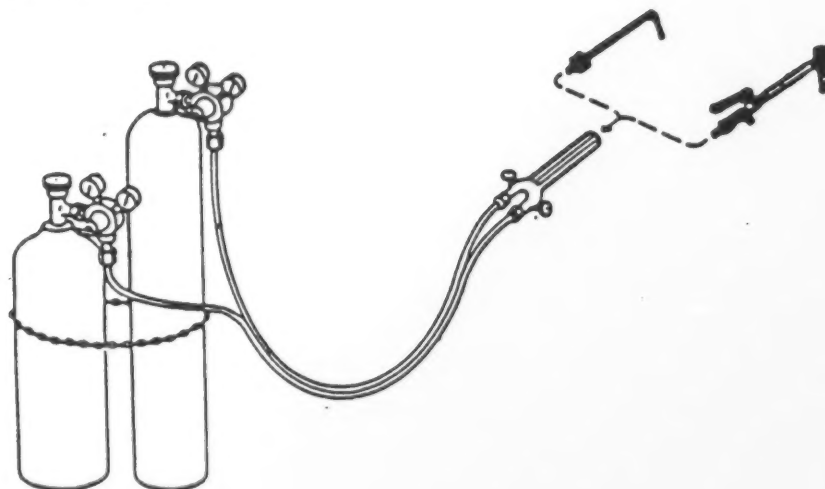
$$\frac{P_1}{P_2} = \frac{5}{2}$$

Explanation: Dalton's Law: $\frac{P_1 \text{ (oxygen)}}{P_2 \text{ (acetylene)}}$

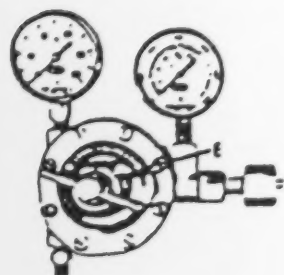


$$\therefore \frac{\text{oxygen}}{\text{acetylene}} = \frac{5}{2}$$

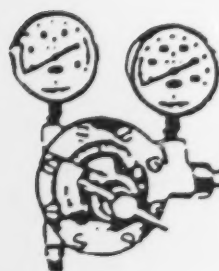
OXYGEN ACETYLENE TORCH



ACETYLENE IS PREFERRED FOR ITS HIGH HEAT AND WIDE AVAILABILITY



OXYGEN



ACETYLENE

REGULATION PRESSURE RATIOS

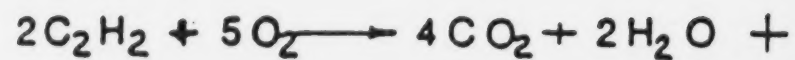
$$\frac{P_1}{P_2} = \frac{\text{PRESSURE OF O}_2}{\text{PRESSURE OF C}_2\text{H}_2} = \frac{5}{2}$$

MATH

OXYGEN ACETYLENE TORCH

SCIENCE

OXIDATION FORMULA:



Title: Rotational Molding

Category: Processes

Description:

Rotational molding is a method used to make hollowed or solid articles from plastisols or powdered mixtures. The mixture is charged into a hollow mold capable of being rotated in one or two planes. The hot mold fuses the plastic mixture into a gel after the rotation has caused it to cover all surfaces. The mold is then chilled and the product stripped out.

The versatility of design for rotational molding is almost unlimited. Typical products include large commercial and industrial containers, traffic cone markers and sporting equipment such as footballs, golf carts, helmets and insulated ice chests.

Title: Rotational Molding

Category: Processes

Science Concepts:

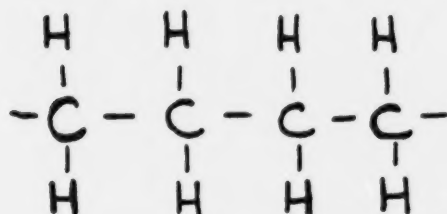
1. Heat and pressure cause chemical changes that make the resin which is used in the molds to harden.
2. Melting Point - Temperature at which a solid, at standard atmospheric pressure, begins to turn into a liquid. For example, the resin is heated until it reaches the melting point.
3. Synthetic resin is made from chemicals that come from such natural sources as coal, limestone, petroleum, salt and water.
4. Synthetic resins consists of billions of tiny invisible particles called molecules. Each molecule contains even tinier particles called atoms - chiefly of carbon, hydrogen, oxygen and nitrogen.
5. Each link of a molecule of synthetic resin is another kind of molecule called a monomer. The entire molecule is called a polymer.
6. Polymerization is a chemical process important in the production of synthetic rubber, plastics, paints, and artificial fibers. In this process, molecules called monomers combine with each other to form larger molecules called polymers.
7. Law of Conservation of Matter - Energy never really disappears, it only changes from one form to another. For example, thermoplastic materials can be melted again and again. They melt when heated to a certain temperature, but harden again as they cool.
8. A catalyst is added prior to pouring the liquid resin into a mold. A catalyst is a substance which speeds up the polymerization or cure of a compound when added in minor quantity as compared to the amount of primary reactants.

Title: Rotational Molding

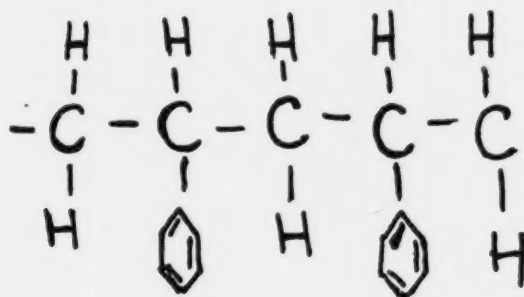
Category: Processes

Description:

9. Polyethylene is produced in two forms in terms of density. Low and intermediate density polyethylenes are produced with a relatively short chain molecular structure and a high degree of side branching. The basic structure for this is:



10. Polystyrene is also used in rotational molding. Polystyrene is a clear, odorless and tasteless polymer whose structure is a long chain, linear, and amorphous. Produced from ethylene and benzene, the polymerized monomer forms a giant molecule with large side groups.



Title: Rotational Molding Processes

Category: Processes

Math Concepts:

1. Volume

$$\pi r^2 h$$

$$lwh$$

$$\frac{4\pi r^3}{3}$$

Cylinder

Rectangular Prism

Sphere

2. Temperature Conversions

$$C = 5/9 (F - 32)$$

$$F = 9/5 C + 32$$

3. Geometry (pertaining to circles)

4. Graphing

5. Time problems

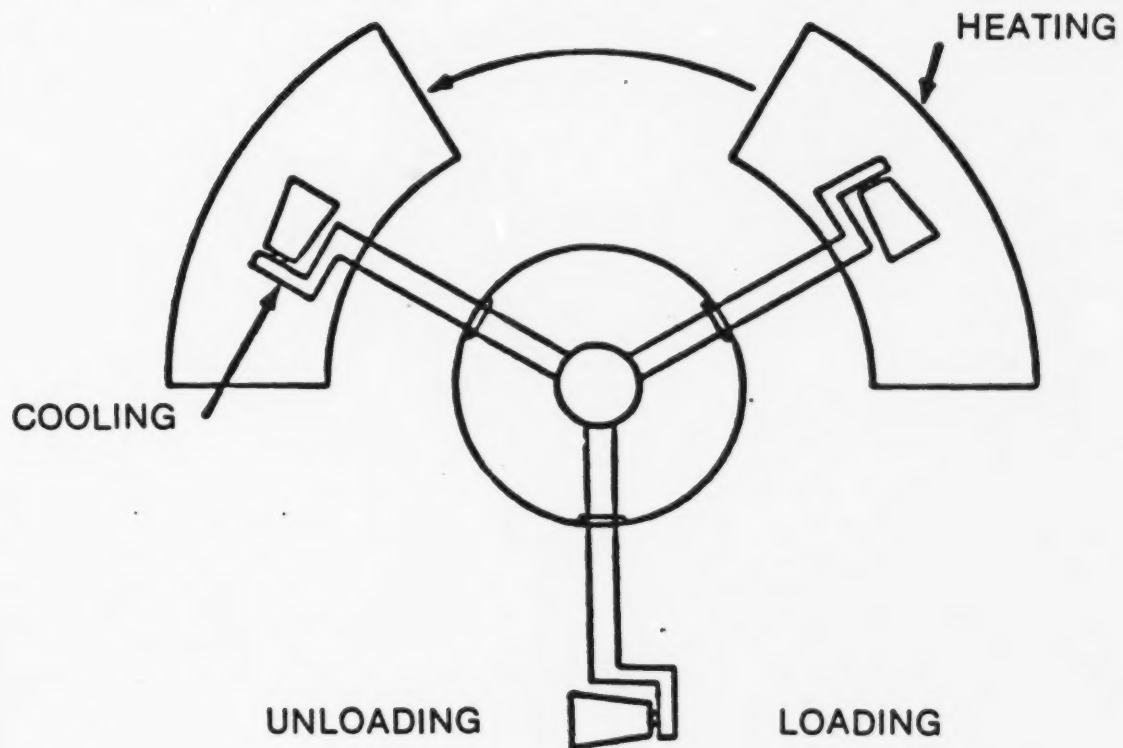
elapsed time

addition of times

6. $D = \frac{m}{v}$

Density = $\frac{\text{mass}}{\text{volume}}$

ROTATIONAL MOLDING



Title: Soldering

Category: Process

Description:

Soldering is a method of using heat to form joints between two metallic surfaces using a nonferrous filler material. (A nonferrous metal is one which contains no iron, therefore, nonmagnetic). Soldering is generally used by plumbers to join rigid copper tubing and fittings. The filler material is distributed evenly between the close-fitting surfaces of the joint by CAPILLARY ATTRACTION. This is the tendency of a liquid to be drawn to the surface of solids in a kind of "soaking" or spreading action.

Science Concepts:

Terms

1. Chemical change - change in which a substance becomes another substance having different properties.
2. Melting point - the temperature at which a substance changes from a solid to a liquid. (tin's melting point = 450° F). When lead is added to tin, it lowers the melting point of the tin to 361° F.
3. Soft Solder - is a fusible alloy used for the purpose of joining together two or more metals at temperatures below their melting points.
4. Hard Solder - is composed of copper, zinc, and silver.
5. Alloy - a mixture of two or more metals.
6. Metal - a substance that has a specific luster, is a good conductor of heat and electricity and can be pounded or drawn into various shapes.
7. Capillary force - the flow of molten, liquid solder into tight joints. (Pathways for solder must be tiny. If the gap is over 0.25 min. the capillary force is lost and the solder will not flow completely around the joint.)
8. Element - a substance which cannot be broken down into simpler substances by ordinary means.

Title: Soldering

Category: Process

Science Concepts:

1. Soldering involves a chemical change. Solder is partly converted to a new and different alloy due to the student action between the respective metals.

2. The advantage of soldered joints are:

A. they are not easily broken by stress (vibrations) or strain due to temperature changes (hot, cold water pipes).

B. a soldered joint is liquid and gas tight. (No leaks).

C. they behave like one solid metal which is essential in the manufacture of electronic and electrical instruments. (television, radio, circuit, boards).

3. Flux (solder paste) protects the hot metal joint from Oxygen in air and makes the joint more likely to react with the molten solder.

4. Elements have symbols.

Lead Pb

Tim Sn

Antimony Sb

Silver Ag

Oxygen O

Title: Soldering

Category: Process

Science Concepts:

Common Alloys of Solder

% Sn	% Pb	% Ag	% Sb	Temperatures at which solder becomes plastic		Temperatures at which solder becomes liquid	
				C°	F°	C°	F°
0	100			278	532	327	620
5	95			234	453	314	597
10	90			183	361	302	576
15	85			183	361	290	554
20	80			183	361	280	538
25	75			183	361	268	514
30	70			183	361	257	496
35	65			183	361	247	477
38	62			183	361	243	468
40	60			183	361	238	460
45	55			183	361	228	437
48	52			183	361	218	424
50	50			183	361	213	414
55	45			183	361	200	392
60	40			183	361	188	370
65	35			Eutectic		183	361
68	32			183	361	164	364
70	30			183	361	156	367
75	25			123	361	192	378
80	20			183	361	199	390
85	15			183	361	205	403
90	10			183	361	213	418
95	5			183	361	222	432
100	0					232	450
95			5	232	450	233	460
25	65		2	187	369	237	459
27	70	3		179	354	253	487
27	60	8		179	354	233	451
61.5	35.5	3		179	354		
62.5	34.1	1.4		Eutectic		179	354
	97.5	2.5		Eutectic		305	581
	95	5		305	581	365	689
0.75	97.5	1.75		Eutectic		310	590

Symbols of Elements

Lead - Pb

Tin - Sn

Antimony - Sb

Silver - Ag

Oxygen - O

Temperature

Celsius Scale = C

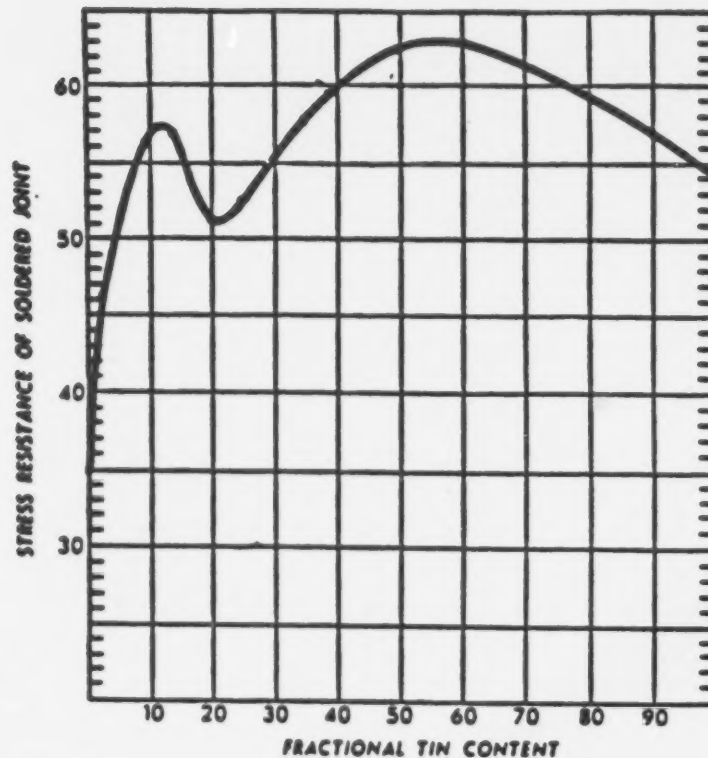
Fahrenheit Scale = F

Degrees °

Title: Soldering

Category: Process

Science Concepts:



Graph showing the change in joining quality of tin-lead solders with increase in tin content, based on resistance of the soldered joint to a simulated bending and torsional stress.

Solder comes in various ratios of tin and lead. They range from pure tin to pure lead. The solder to be used is matched to the joint requirements. Example - 50/50 has a composition of 50% tin and 50% lead

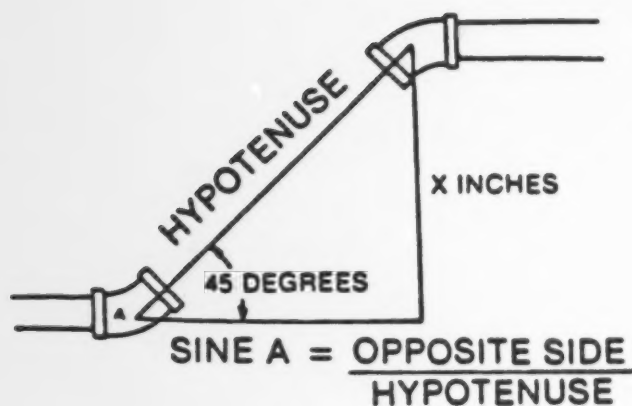
Title: Soldering

Category: Process

Mathematical Concepts:

- 1) Knowledge of ratio - comparison of numbers or a rate .
- 2) Knowledge of percentage - total composition of metals in an alloy should equal 100%.
- 3) Knowledge of fractions - to determine correct fittings (comparison in relation as to whether one nominal size fits into another).
- 4) Knowledge of temperature scale in a relation to melting points both Farenheit and Celsius.
- 5) Knowledge of pythagorean theorem to compute pipe offset $A^2 + B^2 = C$.
- 6) Could use trigonometry in finding pipe offset
Sine A = $\frac{\text{opposite side}}{\text{hypotenuse}}$ Tangent C = $\frac{\text{opposite side}}{\text{adjacent side}}$
- 7) Knowledge of degrees of angles - (use of protractor to demonstrate).

SOLDERING



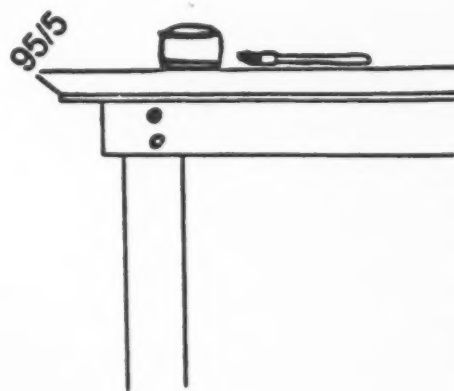
ALLOY: A COMBINATION OF TWO OR MORE METALS.

50 PERCENT TIN (Sn) 50 PERCENT LEAD (Pb)

95 PERCENT TIN (Sn) 5 PERCENT ANTIMONY (Sb)

50/50

95/5



Title: Thermoforming

Category: Processing

Description:

Thermoforming is one of the major processes of the Plastic Industry. A sheet of thermoplastic is clamped in a frame. The clamped sheet is then heated (275° - 400° F) until it becomes soft, but not liquid. The soft sheet of plastic is sealed against the rim of a form. A vacuum is created by removing the air from around the form. Atmospheric pressure is the physical force that forces the limp heated sheet into the shape of the form. The vacuum is held until the sheet becomes rigid after cooling. The newly formed product is removed and trimmed.

Science Concepts:

1. Energy is the ability to produce change.
2. Heat is a form of kinetic energy of molecules.
3. A chemical bond is a force that holds two atoms together in a molecule.
4. Physical change is a change in the size, shape, or state without changing the object's composition.
5. Conduction is the movement of heat through a substance.
6. Atmospheric pressure is the amount of force pushing on a specific object.
7. Vacuum is the removal of air from a given area by reducing the pressure.
8. Temperature is the measurement of the internal kinetic energy of an object.
9. The molecular structure of thermoplastic (its memory) allows for the shaping and reshaping of the plastic.

Title: Thermoforming

Category: Processing

Math Concepts:

1. Identification of geometric shapes

- Examples:
- a. square
 - b. rectangle
 - c. triangle
 - d. circle
 - e. parallelogram
 - f. trapezoid

2. Measuring length and width

3. Computing center

4. Division of simple and mixed fractions

Examples: $\frac{3}{4} \div 2$

$$\frac{3}{4} \div \frac{2}{1}$$

$$\frac{3}{4} \times \frac{1}{2} = \frac{3}{8}$$

$$2 \frac{1}{3} \div 2$$

$$\frac{7}{3} \div \frac{2}{1}$$

$$\frac{7}{3} \times \frac{1}{2} = \frac{7}{6} = 1 \frac{1}{6}$$

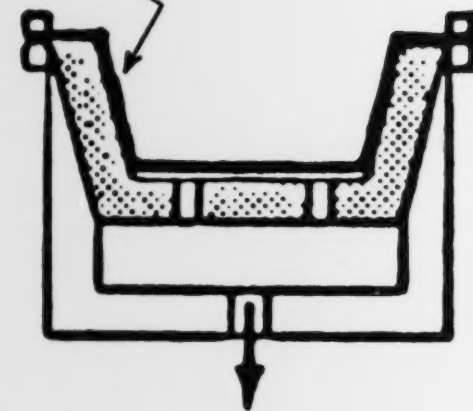
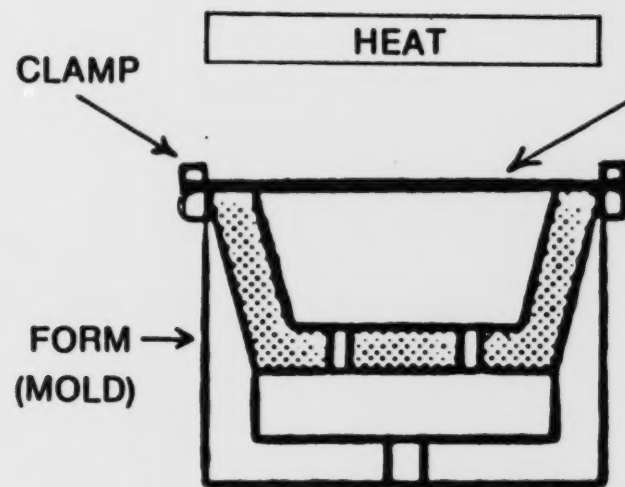
THERMOFORMING

MEASURING

ENERGY

COMPUTATION

PHYSICAL CHANGE

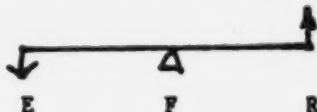


Title: Tin Snips

Description: The purpose of this transparency is to compare the regular pattern snips to the compound action snips. As the comparison takes place, it will be necessary to discuss the lever as a simple machine as well as apply the mathematical formulas for the laws of moments and mechanical advantage.

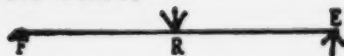
Science Concepts:

1. Tin snips are an example of the simple machine lever.
2. There are three parts to a lever.
 - a. The fulcrum is the support about which a lever turns.
 - b. The effort is the force used to work.
 - c. The resistance is the force which opposes the effort.
3. There are three classes of levers.
 - a. A first class lever has the fulcrum between the effort and resistance.



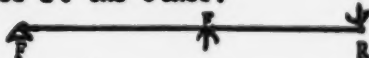
A seesaw is an example of a first class lever.

- b. The second class lever has the fulcrum at one end and the effort at the other.



A wheel barrow being moved is an example of a second class lever.

- c. The third class lever has the fulcrum at one end and the resistance at the other.



Tweezers are an example of a third class lever.

4. The law of the lever is the resistance times the resistance arm length is equal to the effort times the effort arm length.

$$R \times R \text{ arm} = E \times E \text{ arm}$$

5. The mechanical advantage of a lever is determined by the ratio of the length of its effort arm to the length of its resistance arm.

$$\text{M.A.} = \frac{\text{effort arm length}}{\text{resistance arm length}} = \frac{\text{resistance}}{\text{effort}}$$

6. Tin snips use the concept of a first class lever.
7. The cutting edges of a tin snips are wedges.
8. The fulcrum on a tin snips is a rivet. The distance from the rivet to the hands is the length of the effort arm. The distance from the rivet to the point where the metal is cut is the length of the resistance arm. Therefore, the shorter the resistance arm, the less effort required to cut the metal.
9. Tin snips are actually two first class levers sharing a common fulcrum.
10. The compound action snips or aviation snips use a first class lever and a second class lever. See the diagram on the transparency. F_1 , R_1 , E_1 , refer to the first class lever. F_2 , R_2 , E_2 refer to the second class lever. Resistance one (R_1) is the result of effort one and effort two ($E_1 + E_2$). Therefore, more force is applied at R_1 than would be possible with just a first class lever by itself.
11. The compound action snips are two arms each of which contain a first class and a second class lever. Each arm shares both fulcrums with the other arm.

Tin Snips - Vocabulary

1. aviation snips - tin snips with a compound action which take less effort to cut.
2. effort - force used to work.
3. equilibrium - the point at which two forces cancel out each other.
4. force - a push or pull.
5. fulcrum - the support about which a lever turns.
6. inertia - the law that states that a body at rest will stay at rest, unless acted on by an outside force.
7. lever - a simple machine which moves around a fulcrum.
8. mechanical advantage - the number of times a machine multiplies the forces applied to it.
9. ratio - relationship between things.
10. resistance - a force which opposes an effort.
11. rivet - nonthreaded fastener used to make a more permanent assembly of parts.
12. tin snips - a scissors-like tool used to make straight cuts in metal.
13. torque - the tendency of a force to produce rotation about an axis. Also called the moment of force.

Title: Tin Snips

Math Concepts

Description: The purpose of this transparency is to compare the regular pattern snips to the compound action snips. As the comparison takes place, it will be necessary to discuss the lever as a simple machine as well as apply the mathematical formulas for the laws of moments and mechanical advantage.

Tin snips consist of two bars pivoted at the same fulcrum. Consider one of the bars to be fixed, and apply the law of moments to the other.

- (1) E.F. = Effort Force
- (2) R.F. = Resistance Force
- (3) E.A. = Effort Arm
- (4) R.A. = Resistance Arm
- (5) M.A. = Mechanical Advantage

- A. Moment of a force or torque equals E.F. x E.A. or R.F. x R.A.
- B. The law of moments states that a state of equilibrium exists between (E.F. x E.A.) and (R.F. x R.A.). In other words
E.F. x E.A. = R.F. x R.A.
- C. The mechanical advantage of a lever is determined by the ratio of resistance to effort or effort arm to resistance arm.

$$M.A. = \frac{R.F. \times E.A.}{E.F. \times R.A.}$$

- D. Example: Find the resistance force and mechanical advantage for tin snips with E.F. = 10 lb., E.A. = 6 in. and R.A. = 1/2 in.

Solution: Using the law of moments:

$$E.F. \times E.A. = R.F. \times R.A.$$

$$10 \text{ lb.} \times 6 \text{ in.} = R.F. \times 1/2 \text{ in.}$$

$$60 = \frac{R.F.}{2}$$

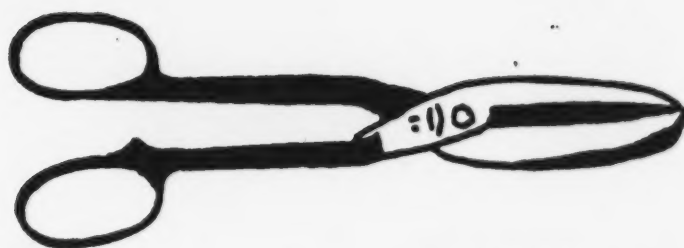
$$R.F. = 120 \text{ lb.}$$

$$\text{TO FIND M.A., USE } M.A. = \frac{R.F.}{E.F.}$$

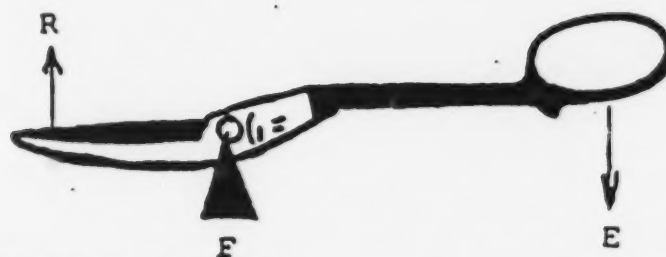
$$M.A. = \frac{120}{10}$$

$$M.A. = 12$$

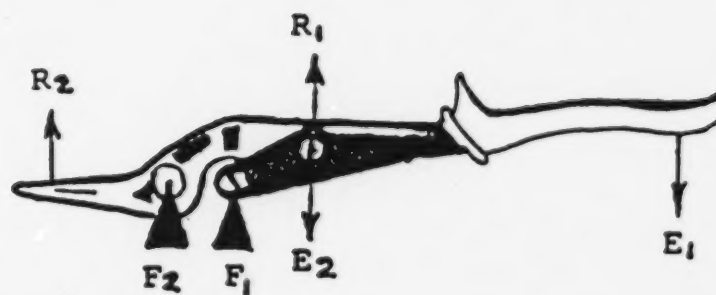
TIN SNIPS



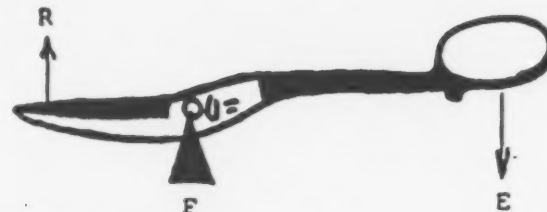
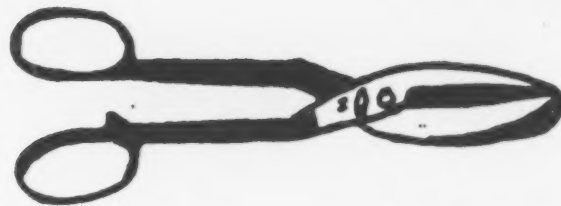
REGULAR PATTERN SNIPS



COMPOUND ACTION SNIPS



TIN SNIPS



REGULAR PATTERN SNIPS

THE LAW OF MOMENTS

$$E.F \times E.A = R.F \times R.A$$

MECHANICAL ADVANTAGE

$$M.A = R.F / E.F = E.A / R.A$$

E.A = EFFORT FORCE

R.F = RESISTANCE FORCE

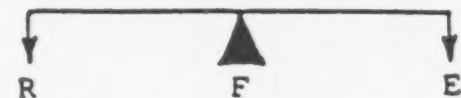
E.A = EFFORT ARM

R.A = RESISTANCE ARM

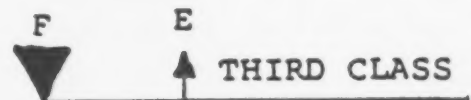
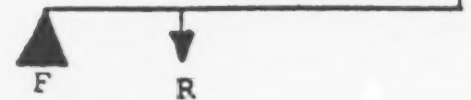
M.A = MECHANICAL ADVANTAGE

**F
O
R
C
E
S**

FIRST CLASS



SECOND CLASS



THIRD CLASS

**L
E
V
E
R
S**

F = FULCRUM

R = RESISTANCE

E = EFFORT

TITLE: WOODWORKING FINISHES

CATEGORY: PROCESS

DESCRIPTION:

Woodworking finishes provide a protective covering which stabilizes the wood. Unfinished wood tends to absorb moisture, fumes, and oils which cause the wood to shrink, swell, check, warp, and discolor. Selected finishes can retard or offset these tendencies. Finishes can be either penetrating or surface, also called build-up.

SCIENCE CONCEPTS:

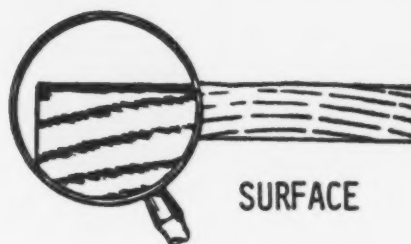
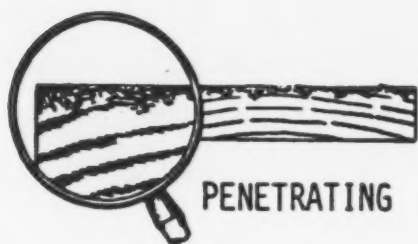
1. Gum. Any one of a class of colloidal substances exuded by, or extracted from plants.
2. Resin. A solid or semisolid noncrystalline organic substance that often softens or melts but not at any definite temperature. They may be natural or synthetic.
3. Alcohol, denatured. Ethyl alcohol to which has been added denaturing material as to render the alcohol unfit for human consumption.
4. Organics. A term that refers to compounds that are carbon based.
5. Dilute solution. A solution containing a relatively small amount of dissolved substance per unit volume of solvent.
6. States of matter. A solid is a part of space that is bounded on all sides and that does not perceptibly flow. A liquid is a form of fluid which is characterized by free movement of the constituent molecules among themselves but without the tendency to separate from one another. A gas is an aeriform fluid having neither independent shape nor volume, but tending to expand indefinitely.
7. Diffusion. The property of matter that explains molecules of one type passing among molecules of another.
8. Alcohol proof. A term expressing the alcoholic content and is twice the percentage by volume of alcohol. Ex. 190 proof is 95% alcohol.

TITLE: WOODWORKING FINISHES

CATEGORY: PROCESS

MATHEMATICAL CONCEPTS:

1. Reading a scale (for flatness of the object).
2. Measuring angles (perpendicular faces of the object).
3. Understanding fractions (choosing the proper size brush and proper sand-paper).
4. Liquid measurement (pints, quarts, and gallons).
5. Calculate surface area.
6. Temperature (of the finish being used, the surface of the object, and the room).
7. Ratio and proportion (amount of the shellac to the amount of alcohol).
8. Percent.
9. Telling time (for the drying process).



PENETRATING - VARIOUS OILS: DANISH, TUNG, MINWAX

SURFACE OR BUILD-UP: SHELLAC, VARNISH, LACQUER

WOODWORKING FINISHES

MATH

LIQUID MEASUREMENT
SURFACE AREA
RATIO AND PROPORTION
PERCENT
TEMPERATURE
TIME

SCIENCE

DILUTIONS
DIFFUSION
STATES OF MATTER
 LIQUID, SOLID
ORGANIC SUBSTANCES
 DENATURED ALCOHOL, GUMS, RESINS

Title: Wood Laminating

Category: Process

Description:

Lamination is the process of building up thickness or width of material by gluing together several layers. Veneers are used in laminations. A veneer is a thin layer of wood. wood laminations resist warpage and reduce the number of splits and checks. They also produce a part that is stronger than regular wood.

Science Concepts

1. Wood is made of fibers.
2. Wood fibers are made of cells surrounded by cellulose.
3. Wood is composed of 3 chemicals: cellulose; hemicellulose; lignin.
4. Wood can be classified as hardwood (deciduous) and softwood (coniferous).
5. The varieties of trees can be identified by certain outward characteristics such as leaves.
6. The varieties of woods can be identified by certain characteristics such as grain pattern.
7. Steam is the gaseous state of water.
8. Heat and moisture can cause expansion and contraction of wood.
9. Molecules of glue can adhere to molecules of wood.
10. Adhesives can be made from animal parts, milk curd, resins, blood protein, vegetable protein, rubber, etc.

Title: Wood Laminating

Category: Process

Math Concepts:

1. Median - have one middle layer when laminating so an odd number of layers are used.
2. Parallel planes - place the layers of wood so that the grain of each layer runs approximately in the same direction.
3. Perpendicular planes - the layers of wood can also be placed so that the grain of each layer runs at right angles to the next layer.
4. Accurate timing for the set-up stage.
5. Coordinate graphing to sketch the product on grid paper.
6. Area formulas applicable to the shape of the product.

Examples: Area of parallelogram = base x height

Area of triangle = $\frac{1}{2}$ x base x height

Area of circle = $\pi \times r^2$

7. Addition and subtraction of fractions for the purpose of accurately using layout and measuring tools.
8. Percents - when bending the wood the outside will stretch only 1 to 2 percent and the inside will compress as much as 25 percent.
9. Radius and diameter of a circle.
10. Use of bend allowance of wood formulas.

Thickness of hardwoods x 40 = minimum radius around

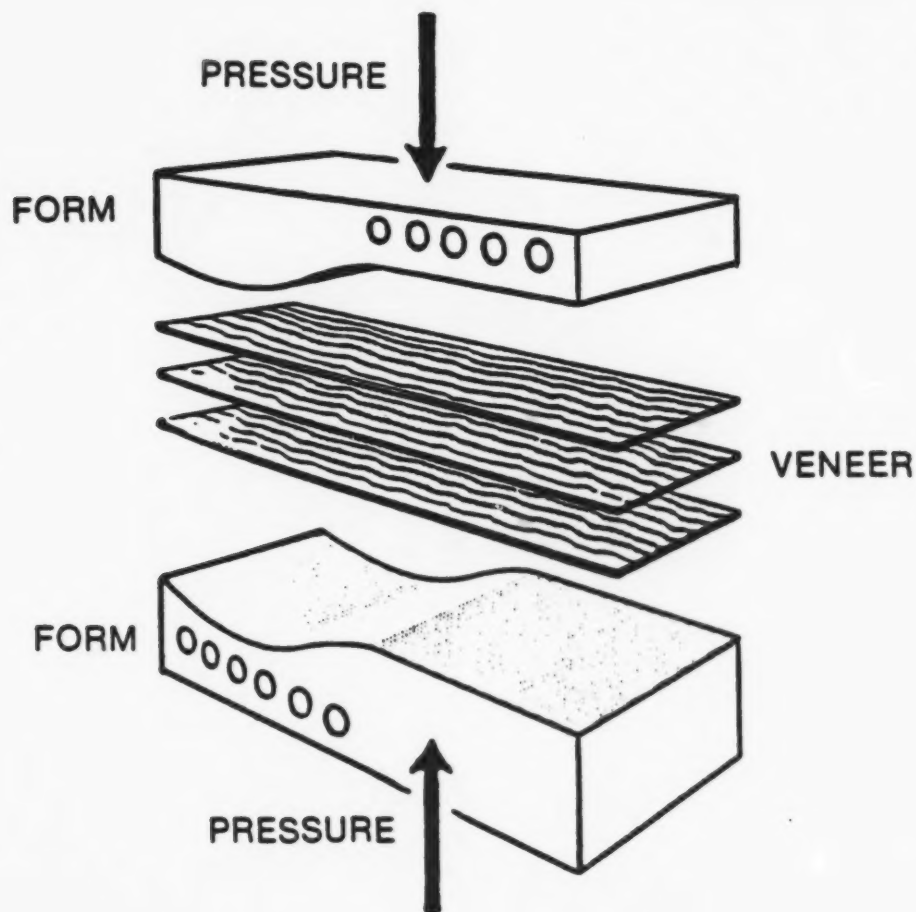
which hardwood can be bent

Thickness of softwood x 60 = minimum radius around

which softwood can be bent.

11. Reading a chart to select the proper blade of a bandsaw. Blades range in width from 1/16 inch to 3/4 inch. The width of the blade determines the minimum radius which the blade can cut. For example, a 1/2 inch blade cannot cut a circle smaller than 2 1/2 inches in diameter.

WOOD LAMINATING



MATH CONCEPTS

$$A = L \times W$$

COORDINATE GRAPHING

BEND ALLOWANCE FORMULAS

PARALLEL PLANES

SCIENCE CONCEPTS

BENDABILITY OF WOOD FIBERS

BONDING OF WOOD FIBERS

STRUCTURAL STRENGTH

TITLE: WOODWORKING STAINS

CATEGORY: PROCESS

DESCRIPTION:

The purpose of staining wood is to produce a rich and mellow color. Stain is a transparent liquid that is applied to wood in order to improve its appearance, bring out the grain, or imitate a more expensive wood. Stains may be applied with a brush, rag, or sponge. The excess is then removed with a clean cloth, and the wood is allowed to dry for 24 hours.

SCIENCE CONCEPTS:

1. Absorption rate due to density.
Stain is absorbed more slowly in wood that has small, densely packed cells, while wood with large, non-densely packed cells absorbs stain rapidly.
2. Evaporation rate of stains.
Water base stains dry more quickly than oil base stains because water has a more rapid evaporation rate than oil.
3. Streaking due to gravity.
Uneven coverage or streaking due to the pull of gravity on a liquid can be avoided by applying the stain to a horizontal surface.
4. Composition of stains.
Oil base stains are produced by adding inorganic (non-carbon containing) pigments to organic (carbon containing) solvents. Water base stains are produced by adding aniline (organic) dyes to water.

MATHEMATICAL CONCEPTS:

1. Reading a scale (for flatness of the object).
2. Measuring angles (perpendicular faces of the object).
3. Understanding fractions (choosing the proper sandpaper and choosing the proper size brush).
4. Liquid measurement (pints, quarts, and gallons).
5. Calculate the surface area.
6. Calculate the density of the wood (for absorption of the stain).
7. Temperature (of the stain, the room, and the surface of the object).
8. Ratio and proportion (the amount of stain to the area of the wood).
9. Telling time (for the drying process).

OIL BASE

ADV.- EASY APPLICATION, WIDE COLOR RANGE

DISADV.- LONG DRYING TIME

WATER BASE

ADV.- EVEN COLOR, LESS EXPENSIVE

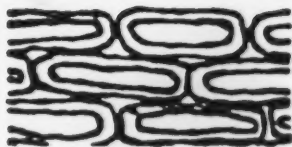
DISADV.- RAISES GRAIN



$$\text{DENSITY} = \frac{\text{MASS}}{\text{VOLUME}}$$

WOODWORKING STAINS

ABSORPTION OF STAIN



POROUS

LOW DENSITY : LARGE CELLS

PINE CEDAR REDWOOD



SEMI-POROUS

MEDIUM DENSITY : MEDIUM CELLS

MAPLE BIRCH GUM



NON-POROUS

HIGH DENSITY : SMALL CELLS

OAK MAHOGANY WALNUT

Title: Woodturning (Faceplate Turning)

Category: Process

Description:

Faceplate turning differs from spindle turning in two respects: first, in the way in which the work is mounted on the lathe; and second, in the method of using the turning tools. In faceplate turning the stock is fastened to a faceplate which is screwed to the headstock spindle and is supported entirely by the faceplate.

Math Concepts:

1. Properties of a square to include perpendicular lines and the fact that diagonals intersect in the center.
2. Geometric Constructions - use of a compass to scribe a circle.
3. Properties of a circle to include radius and diameter.
4. Accurate measurement when drawing a full size sketch of the product or template of the product.
5. Use of fractions and/or decimals when using the measuring tools.
(ruler, inside calipers, dividers)
6. Understanding of the concepts of parallel to and perpendicular to when placing the tool rest.
7. Accurate use of the speed control of the lathe for example, use slow speed for the first cuts, especially on large diameter stock that is thick or heavy.
8. Use of fractions to choose the correct size of scraping tool.

Title: Woodturning (Faceplate Turning)

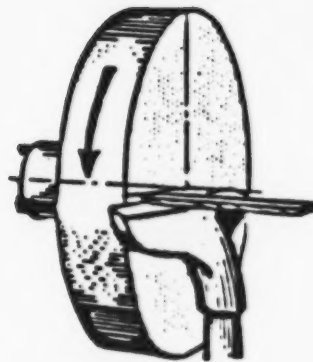
Category: Process

Science Concepts:

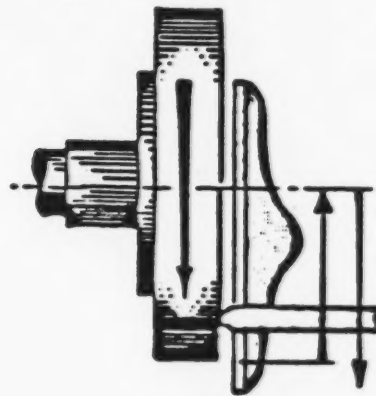
1. Wedges are used to separate.
2. Friction causes heat.
3. Lubrication decreases friction.
4. The coefficient of friction = $\frac{\text{Force}}{\text{Weight}}$
5. Abrasives use friction.
6. Changing gear ratios or pulley ratios changes output rpm's.
$$MA_s = \frac{\text{Distance of Resistance}}{\text{Distance of Effort}}$$
7. Changing gear ratios or pulley ratios changes output force.
$$MA_f = \frac{\text{Force of Resistance}}{\text{Force of Effort}}$$
8. The outermost surface speed of a large-diameter rotating object is greater than the outermost surface speed of a small-diameter rotating object when the same rpm's are applied.
9. Centrifugal force impels an object outward from the center of rotation.
10. Wood is made of fibers.
11. Wood fibers are made of plant cells.
12. Wood contains water.
13. Water can evaporate.
14. Different grain patterns determine the turning characteristics of a piece of wood.

WOODTURNING

FACEPLATE TURNING



SIDE VIEW



TOP VIEW

MATH CONCEPTS

PROPERTIES OF A CIRCLE

GEOMETRIC CONSTRUCTIONS

COMPASS, CALIPERS, DIVIDERS

$$R = \frac{1}{2}D$$

SCIENCE CONCEPTS

STRUCTURE OF WOOD

RPM

PULLEY RATIOS

SURFACE SPEED CHANGES

$$MA_s = \frac{\text{DISTANCE OF RESISTANCE}}{\text{DISTANCE OF EFFORT}}$$

Title: Woodturning (Spindle Turning)

Category: Process

Description:

The woodworking lathe is a basic machine which has been used by woodworkers through the years. Like all other types of equipment used in the woodworking trade, it has gone through many different changes. Its basic principle and fundamental purpose remain the same: revolving wood at various rates of speed while the operator makes various cuts, shapes, and forms with hand tools. Spindle turning includes all turning operations on stock that is held between live and dead centers. These are: straight and taper turning, shoulder cuts, rounds, beads, and split turning.

Math Concepts:

1. Proportions are used to make a drawing - to - scale of the piece to be made.
2. Properties of a square to include perpendicular lines and the fact that the diagonals intersect in the center.
3. Properties of cylinders.
4. Circumference = $2 \times \pi \times r$ or $\pi \times d$
5. Use of fractions and/or decimals when using the measuring tools. (ruler, outside spring calipers, inside spring calipers).
6. Angles -
 - a) angles of woodturning chisels
 - b) grinding angles of woodturning chisels
 - c) angle to hold the chisel to the work
7. Accurate use of the speed control of the lathe. The larger the stock to be turned, the slower the speed required.
8. Tangent - cutting edge of the skew chisel should be tangent to the face of the cylinder.

Title: Woodturning (Spindle Turning)

Category: Process

Science Concepts:

1. Wedges are used to separate.
2. Friction causes heat.
3. Lubrication decreases friction.
4. The Coefficient of Friction = $\frac{\text{Force}}{\text{Weight}}$
5. Abrasives use friction to remove material.
6. Changing gear ratios or pulley ratios changes output rpm's.

$$MA_s = \frac{\text{Distance of Resistance}}{\text{Distance of Effort}}$$

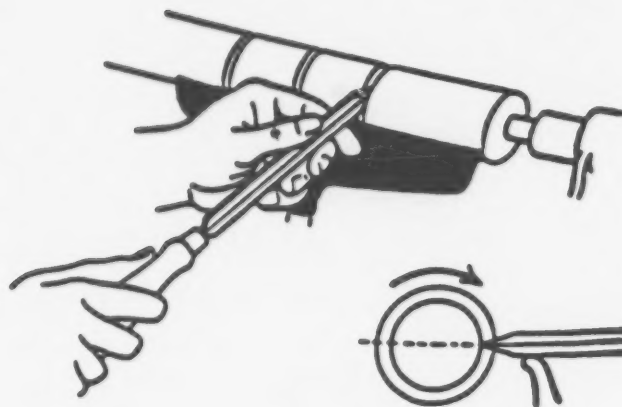
7. Changing gear ratios or pulley ratios changes output force.

$$MA_f = \frac{\text{Force of Resistance}}{\text{Force of Effort}}$$

8. The outermost surface speed of a large-diameter rotating object is greater than the outermost surface speed of a small-diameter rotating object when the same rpm's are applied.
9. Centrifugal force impels an object outward from the center of rotation.
10. Wood is made of fibers.
11. Wood fibers are made of plant cells.
12. Wood contains water.
13. Water can evaporate
14. Different grain patterns determine the turning characteristics of a piece of wood.

WOODTURNING

SPINDLE TURNING



MATH CONCEPTS

MEASURING TOOLS

CENTERING

ANGLES

$$C = \pi \times d$$

SCIENCE CONCEPTS

MECHANICAL ADVANTAGE

WEDGES

CENTRIFUGAL FORCE

LUBRICATION

$$MA = \frac{R}{E}$$

TITLE: WOODWORKING WAXES

CATEGORY: PROCESS

DESCRIPTION:

Wax is used to produce a hard, tough film on a surface. This film protects the wood, making it water repellant and abrasion resistant. Waxes are available in either a liquid or a paste. Both are made from beeswax, paraffin, carnauba wax, and turpentine.

SCIENCE CONCEPTS:

1. Wax

Any one of a class of substances of plant or animal origin, insoluble in water, partly soluble in alcohol, ether, etc. and miscible in all proportions with oils and fats.

2. Taxonomy

The scientific nomenclature for living organisms.

3. Specific Gravity

The ratio of the weight of any given volume to the weight of an equal volume of some other standard substance at a stated temperature.

4. Solidification Point

The temperature at which any liquid changes into a solid.

5. Melting Point

The normal melting point of a solid is the temperature at which a solid becomes a liquid.

6. Saponification number

The number of milligrams of potassium hydroxide required for complete saponification of one gram of substance.

TITLE: WOODWORKING WAXES

CATEGORY: PROCESS

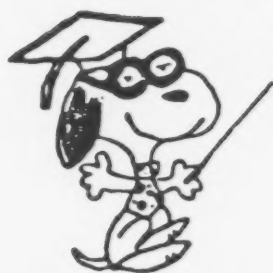
MATHEMATICAL CONCEPTS:

1. Reading a scale (for flatness of the object)
2. Measuring angles (perpendicular faces of the object)
3. Understanding fractions (fillet sizes)
4. Ratio and proportion (for specific gravity - compare the density of the wax to the density of water)
5. Volume
6. Metric System
7. Liquid measurement (pint, quart, gallon)

WOODWORKING WAXES



WAXES ARE USED TO PROTECT THE WOOD'S SURFACE, AND TO SIMULATE THE "HAND-RUBBED" FINISH. WOODWORKING WAXES ARE COMPOSED OF BEESWAX, PARAFFIN, CARNAUBA WAX, AND TURPENTINE.



LIQUID MEASUREMENT	RATIO
PROPORTION	DECIMALS
FRACTIONS	PERCENT
TEMPERATURE	TIME

TYPES OF WAXES

	SPECIFIC GRAVITY	MELTING POINT °C	SCIENTIFIC NAME
CARNAUBA	0.964	-17	CORYPHA CERIFERA
JAPAN	0.975	43	RHUS SUCCEDANEUM
BEESWAX	0.965	16	APIS MELLIFERA
CHINESE	0.810	29	COCCUS CERIFERA
SPERMACE	0.932		PHYSTER MACROCEPHALUS

